Máster Internacional en
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Assessment of Profitability and Employment in the Spanish Mediterranean Fishing Fleet

MOUNIRA ALKASSAR

Septiembre 2019

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Alicante

a 24 de septiembre de 2019

Assessment of Profitability and Employment in the Spanish Mediterranean Fishing Fleet

MOUNIRA ALKASSAR

Trabajo realizado en El Centro Mediterráneo de Investigaciones Marinas y Ambientales de Barcelona, España, bajo la dirección de Dr. Dr. MAYNOU HERNÁNDEZ, F. JAVIER.

Y presentado como requisito parcial para la obtención del Diploma Master of Science en Gestión Pesquera Sostenible otorgado por la Universidad de Alicante a través de Facultad de Ciencias y el Centro Internacional de Altos Estudios Agronómicos Mediterráneos (CIHEAM) a través del Instituto Agronómico Mediterráneo de Zaragoza (IAMZ).

Esta Tesis fue defendida el día 24 de septiembre de 2019 ante un Tribunal Formado por:

- Aitor FORCADA ALMARCHA
- Bernardo BASURCO DE LARA
- Jordi GUILLEN GARCIA

In memory of my father

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« L'observation et l'étonnement sont les premiers pas de l'esprit vers la recherche de causes »

Denis Diderot

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Abbreviations

AER: Annual Economic Report

Art: Small-scale fleet

BER: Break-even revenue

CFP: Common Fisheries Policy

CR: Current revenue

CPI: Consumer Price Index

DCF: Data Collection Framework

DTS: Demersal trawlers and/or demersal seiners

EU: European Union

GCF: Gross Cash Flow

GVA: Gross Value Added

FTE: Full time equivalent

MAPAMA: Ministerio de Agricultura, Alimentación y Medio Ambiente

MSY: Maximum sustainable yield

NP: Net Profit

PS: Purse seiners

RoFTA: Rate of Return on Fixed Tangible Assets

SMI: inter-professional wage (salario medio interprofesional)

SMA: average annual wage (salario medio annual)

TRP: Interest-rate risk-free

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Summary

This work has been carried out in the context of the European project PANDORA (PAradigm for Novel Dynamic Ocean Resource Assessments link: https://www.pandora-fisheries-project.eu/) Horizon 2020. It aims to analyse and evaluate the current bioeconomic situation of the Spanish Mediterranean fishing fleet and to offer recommendations to ensure the long-term sustainability of fish stocks (maximum sustainable yield "MSY" and maximum economic yields "MEY").

During the execution of the work, the official economic and biological data of the European Commission, collected in STECF reports and databases, have been analyzed for the entire Spanish fleet in FAO area 37 (GFCM areas 1, 5 and 6).

The results showed that a negative trend of economic indicators (net profit, ROFTA, GVA), highlighted a poor economic performance, an inefficiency and overcapacity, had been recorded for all physical capacity indicators regardless the fishing techniques until 2013-2014, followed by an increase in the last 3-4 years with the highest profitability observed for purse seiners. Furthermore, results of stock assessments demonstrate that stocks are still largely overfished and/or in a bad state. The comparison between the actual situation and the maximum sustainable yield, showed a good profitability, a long-term efficiency and a good standard living of fishers. Results of fitted models showed that fuel costs represent the most important operational cost for all fleets. Where, it played a key role in explaining net profit. However, fitted models of GVA and wages of crew demonstrated the key role of fuel costs and fishing technique in addition to average landing prices.

It is concluded that, the introduction of a management system that aims at reducing overcapacity while promoting the recovery of overfished stocks seems urgent. Moreover, the considerable variation in economic performance within and between the three fleets highlights the need of future surveys, better knowledge on population status and market prices.

Keywords: FAO Area 37, Bioeconomics, Profitability, Employment, Fleet segments, Capacity, Fisheries management

RESUMEN

Este trabajo se ha desarrollado en el contexto del proyecto europeo PANDORA (PAradigm for Novel Dynamic Ocean Ressource Assessments link: https://www.pandora-fisheries-project.eu/) Horizon 2020. Consiste en el análisis y la evaluación de la situación bioeconómica actual de la flota pesquera española en el Mediterráneo así como también ofrecer recomendaciones sobre cómo garantizar la sostenibilidad a largo plazo de las poblaciones de peces (rendimiento máximo sostenible “MSY” y rendimiento máximo económico “MEY”).

Durante la ejecución del trabajo se han analizado los datos económicos y biológicos oficiales de la Comisión Europea, recogidas en informes y bases de datos del STECF en lo que se refiere a toda la flota española en la área FAO 37 (áreas CGPM 1, 5 y 6).

Los resultados mostraron una tendencia negativa de los indicadores económicos (beneficio neto, ROFTA, GVA), destacando una ineficiencia y sobrecapacidad económica, para todos los indicadores de capacidad física, hasta el período 2013-2014. Seguida de un aumento en los últimos 3-4 años, con la rentabilidad más alta observada por los cerqueros. Por otra parte, los resultados de las evaluaciones de las poblaciones demuestran que todavía se encuentran en gran medida sobreexplotadas y/o en mal estado. Los resultados del rendimiento máximo sostenible mostraron una buena rentabilidad, una eficiencia a largo plazo y un buen nivel de vida de los pescadores. Los resultados de los modelos ajustados mostraron que los costes de combustible representan el coste operativo más importante para todas las flotas. Jugó un papel clave en la explicación del beneficio neto. Sin embargo, los modelos ajustados de GVA y los salarios de la tripulación demostraron el papel clave de los costes de combustible y de la técnica de pesca, además de los precios medios de los desembarques. La introducción de un sistema de gestión destinado a reducir el exceso de capacidad y promover al mismo tiempo la recuperación de las poblaciones sobreexplotadas parece urgente. Además, la considerable variación de los resultados económicos dentro de las tres flotas y entre ellas pone de manifiesto la necesidad de realizar estudios en el futuro y de conocer mejor la situación de la población y los precios de mercado.

Palabras claves: Área FAO 37, Bioeconomía, Rentabilidad, Empleo, Segmentos de flota, Capacidad, Gestión de pesquerías

General Overview

Fishing is an essential activity to ensure the food supply of a growing world population by providing 20% of the protein intake to approximately 3 billion people, rising to 70% in coastal countries. It is also the main source of livelihood for 10% of the world's population (FAO, 2016). In the Mediterranean, fishing activity represents about 1.6% of world catches and it accounts for 4% of its value (FAO, 2018).

The Mediterranean Sea covers an area of about 2.5 million km² (excluding the Black Sea), which represents almost 0.7% of the total ocean surface area. The rivers of this semi-enclosed sea that feed it along its 46 thousand kilometres of coastline have a high rate of endemism among freshwater species (Garcia et al., 2010). It has an average depth of about 1,500 m, with a peak at nearly 5,200 m in the Ionian Sea (Zenetos et al. 2002). The unique water circulation system of the Mediterranean Sea, due to its oceanographic environmental conditions, creates highly productive upwelling areas, particularly along the coasts, especially near major cities and in estuaries (IUCN, 2012).

It is considered a biodiversity hotspot, given the exceptional diversity of species it abounds in for a temperate sea (FAO 2003a and 2003b). It is the habitat of nearly 7% of the world's marine fish species (Bianchi y Morri, 2000), and has a wide variety of species living in both temperate and tropical zones. There are currently more than 600 marine fish species in the Mediterranean Sea, most of which come from the Atlantic (Quignard y Tomasini, 2000).

In the last 50 years, the Mediterranean Sea has lost 41% of marine mammals and 34% of the total fish population. This biodiversity is threatened by pollution, climate change and over-fishing (Chiara et al., 2017). According to FAO monitoring of assessed stocks, the state of marine fish stocks has continued to deteriorate. In 2015, stocks exploited at the maximum sustainable level (formerly called "fully exploited stocks") represented 59.9% of the total assessed stocks, compared to 7% of overexploited stocks (FAO, 2018). According to scientific stock assessment reports, 93% of its stocks are in a state of overexploitation (Cepesca, 2017).

Most of the nine Mediterranean Sea EU Member States fleets (Croatia, Cyprus, France, Greece, Italy, Malta, Portugal – one vessel, Spain, Slovenia) are wholly dependent on the region. The exceptions were Portugal, Spain and France, which also have major parts of their fleets operating in the Atlantic and other fishing regions. Moreover, the main species fished in the region include anchovy, sardine, and hake. While a number of EU stocks in Northern Europe begin to show recovery signs, scientific advice on the Mediterranean paints a far breaker picture. Despite success stories like the partial recovery of Bluefin tuna, in the Mediterranean stocks are largely overfished and/or in a bad state, in particular stocks exploited mainly or exclusively by the EU fleets. Under the reformed EU Common Fisheries Policy (CFP), fishing limits must be set at sustainable/MSY levels no later than 2020. To comply with the CFP and stop overfishing, scientists are calling for the average reduction of fishing effort in the Mediterranean between 50% and 60%. However, even this may not be sufficient (ENT, 2016).

According to a recent study[1] of Daniel Pauly and Dirk Zeller from the Sea Around Us Project, estimate that during the period between 1950 and 2010, Mediterranean catches were 50% higher than reported by FAO, where its decline is more strong since the 1990s. For some of the Mediterranean countries such as Italy, the study estimates that in the same time period "the total catch was 2.6 times the data presented by FAO" and that illegal unreported fishing represented 54% of all catches. For France, Mediterranean catches were calculated more than twice the official data, whereas for Greece the reconstructed catches were 57% larger than the nationally reported data for the same time period (MEDREACT, 2016).

Spain has the most important fleet in the EU in terms of capacity (GT), with 23.6% of the total and occupies third place in the Community fleet in number of vessels, with 11% being 9,299 vessels out of a total EU 83,780 vessels. It represents 0.39% of the world fleet, which totals 4.6 million vessels. Spain is the first industrial producer in the EU in fishery products with 20% of the EU production (Cepesca, 2017).

However, the Spanish Mediterranean (i.e. FAO area 37.1.1) fishing fleet, contributing with 26% of total number of the Spanish fleet, consisted of 2563 registered vessels of which 567 trawl units represent 7% of the total, 216 purse seiners have been

[1]: Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. Pauly & Zeller. January 2016.

active and represent less than 3% and the rest almost 90% are minor gears. With a combined gross tonnage of 55,912 tonnes, engine power of 222 thousand kW, and an average age of 39 years (STECF, 2018). Its production drop from 139,869 tonnes in 1996 to 71,841 tonnes in 2006. Almost a 51% reduction over 10 years (FishStat, 2018).

The evolution of trawler and purse seiners' fleet in terms of number of vessels, GT and kW as detailed in fig.1 is characterized by a marked reduction in capacity (vessel numbers, kW and GT) between 2008 and 2016; either it is improved during the last year in 2017. Where, the average rate of decreasing between 2015 and 2016 was estimated respectively with 3% and 4% respectively for trawler and purse seiners' fleet. As opposed, the small-scale fleet's capacity has continued to increase since 2014. That, the average rate of increase was around 4% in terms of vessel numbers, kW and GT during the last year (STECF, 2018).

Mapama data have shown that during 2008 a clear inactivity of the artisanal fleet of 0 to 10 meters in length was observed, which is maintained during the following year (2009-2010) to reach an inactivity rate greater than 20%. Between 2011 and 2017, the operational capacity of the fleet was improved, including the artisanal fleet (0-12 meters) for which in 2011-2012 it was slightly unbalanced by inactivity, in the years 2013-17 has been adjusted. However, there is still a large percentage of inactive vessels in the segment 0-6 of the Spanish Mediterranean although improving since 2011 (MAPAMA, 2018).

In terms of employment, as illustrated in table 1, the small-scale fleet is considered as the largest fleet in Spain that contributes with 40% of the fishing employment in the area. Where the majority of workers comes from the segment 06-12m and the segment 12-18m that contribute with 65% and 24% respectively of total employments generated by the fleet. However, trawler and purse seiners' fleets generate correspondingly 31% and 8% of the total number of employment operate in the zone. That the segment 18-24m provides the majority of works which represents almost half of the fishing employment of the trawl fleet and 47% in the case of purse seiners. As the case of capacity, during the period 2008-2016, the Spanish Mediterranean fleet recorded an important fall in the number of jobs. Where the average rate of decreasing between 2015-2016 is estimated with 6%, 17% and 4% correspondingly to trawler, purse seiners and small-scale fleet (STECF, 2017).

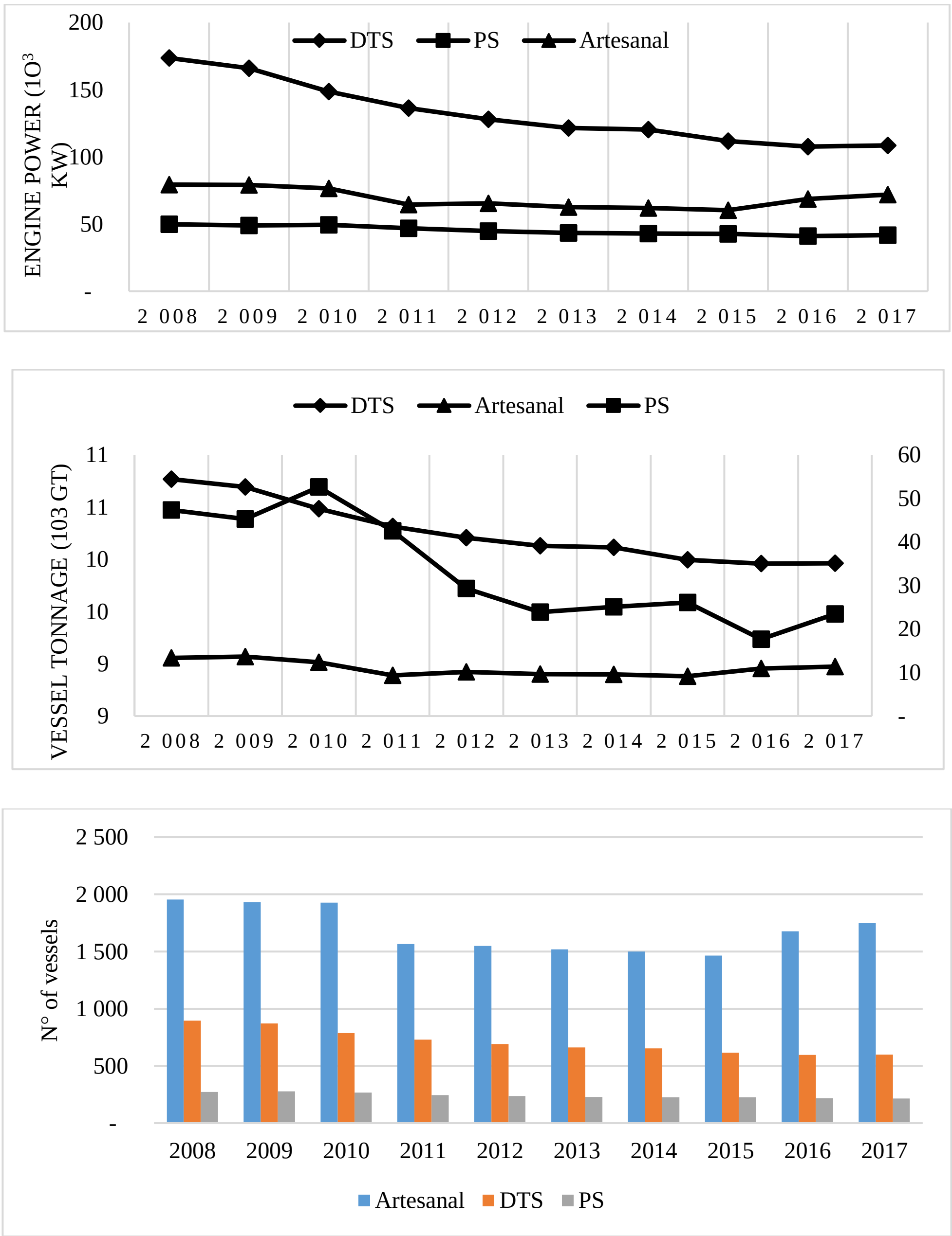


Figure 1: Fishing capacity by fishing technique (DTS: trawler fleet, PS: purse seiners, Artesanal: small-scale fleet)

<u>In terms of production</u>, a large fleet practicing a mixed and multi-species fishery in which 68.16% are small-scale fisheries, boats of less than 12 meters in length. It is followed in importance by the trawl fleet (DTS), aimed primarily at hake (FAO code HKE), red mullet (FAO code MUR) which are considered species at high risk (MAPAMA, 2018). However, the purse seine fleet catches species with pelagic behavior, highlighting among others the sardine, both in the GSA 06 and GSA 01, a stock that is considered at high risk (MAPAMA, 2017), and almost depleted (a fall of 30% of production in Spain in 2016),

anchovy, horse mackerel. Within this fleet, there are six vessels, the largest, are authorized to fish for Bluefin tuna. Operating 10 days per year, landed 691 tonnes and generated more than 7 million euros.

In addition, the latest assessment for the main small pelagic stocks in Mediterranean waters as illustrated in table 2 indicated that they are exploited unsustainably. Spanish fleet operates mainly within four GSAs (excluding GSA2, which only supports a deep trawl fishery around Alboran Island). The following species have been chosen taking into account the landing weight and landing value, these species are under quota, and they can be divided according their distribution to the ICES zone in different stocks by North and South (STECF, 2018).

Table 1: Description of the Spanish Mediterranean fishing fleet (STECF, 2018)

Variable		Trawler	Purse seiners	Small-scale
Capacity	N° of vessels	600	216	1747
	Gross Tonnage	35 thousand tonnes	9 thousand tonnes	11 thousand tonnes
	Engine power	108 thousand kW	41 thousand kW	71 thousand kW
Employment	FTE	2315	1824	2069
	Number of employment by fleet segment	06-12m: 38 12-18m: 453 18-24: 1263 24-40: 671	06-12m: 120 12-18m: 765 18-24m: 1041 24-40m: 306	00-06m: 195 06-12m: 2074 12-18m: 771 18-24m: 185
	Job loss	Going from 2576 to 2425 fishers	Going from 2624 to 2180 fishers	Going from 4048 to 3174 fishers
Production	Live weight landed	22,336 Tonnes	44,094 Tonnes	15 thousand Tonnes
	Value of landings	152 million euros	70 million euros	87 million euros
	Targeted species	European hake (HKE), Red mullet (MUT), Blue and Red shrimps (ARA)	Anchovy (ANE), Sardine (PIL)	Mixed fishery

Indeed, overexploitation, unexpected changes in the productivity of stocks, trade agreements opening EU markets to external fleets to get fishing opportunities and fluctuations in the price of fuel and other business costs jeopardize the sustainability of European fleets by making loses. It is therefore important to implement new management measures to ensure the biological and socio-economic sustainability of the fisheries sector. In addition, the economic importance of the fisheries sector requires special attention from managers. Thus, the EU public authorities have made it a priority in the socio-economic and bioeconomic planning of the countries. Further, most management strategies aim to ensure sustainable and effective fisheries while improving the income, employment and living standards of fishing communities. In order to achieve these often-contradictory objectives, fisheries managers need information on not only the state of fish stocks, as well as the profitability of the fishing fleet.

To maintain an economically healthy and sustainable fleet, management policies may include limiting fishing effort to maintain fish stocks at sustainable levels or to safeguard reasonable rates of return for fisherman in the fishery. When designing and implementing management instruments that are more compatible with the objective of economic efficiency. Fisheries managers should be able to know the answers to questions such as the following:

- "The fleet is profitable?"
- "Do large vessels perform better than smaller ones?"
- "Do vessels using a specific fishing gear perform better than others?"
- "What is the average crew salary?"

In practice, the evaluation of the economic results of fishing fleet is derived from the costs and benefits of fishing. Generally, this type of studies are based on a standard accounting framework and the result is a shot of the current economic situation of a fishery from which various economic and social indicators can be derived. Therefore, cost-benefit studies provide useful information to managers on the economic and social surplus levels generated at any given time.

Economic and Social indicators provide slightly different information and the distinction between the two profit measures is important for management purposes. If the main management concern is the livelihoods of fishers and fishing communities, then the social indicators and the measures of vessel income could indicate the degree of financial hardship faced by vessel operators. The manager could use this information to assess the acceptability of management measures, such as quota reductions or subsidy withdrawals, whose short-term impact will be to reduce fishing income.

Social profitability indicators may also provide some context to the driving forces behind observed fishing behaviours, for example, positive economic profits at the fleet segment may reveal how owners continue to operate in a fishery that is experiencing economic loss.

Generally, the economic profitability is the most appropriate measure for indicating the sector's short, medium or long-term sustainability. If the question concerns the level of fishing effort, then economic profitability indicators are more appropriate since positive economic profits may signal the entry of new vessels into a fishery, intensifying pressure on stocks and increasing the need for entry controls.

Conversely, losses may foreshadow the withdrawal of labour and capital from a fishery, implying redundant capacity or else the allocation of effort to other fisheries. By taking into account all explicit and economic costs, the economic profit indicates the economic return to society associated with harvesting that fishery resource, and is most relevant to the needs of fishery managers. In simple terms, if the analysis is intended to provide an indication of the segment's or sector's ability to survive in the long-term, economic performance is more appropriate.

In many ways, the fishing sector, in the case of Spain, constitutes a sector in its own right that attracts the greatest interest for its important contribution to social progress but also a very important economic gain and foreign exchange for the country. Indeed, the Spanish Government has systematically supported this sector by establishing a fairly comprehensive regulatory and institutional base, in line with international requirements, the supervision and regular monitoring of fishing campaigns, the launching of development projects in its favor, such as the implementation of the Fisheries Improvement Project (FIP) of the Organization of Associated Producers of Large Freezer Tuna Vessels (OPAGAC) in collaboration with WWF; the entry into force of the Agreement on Port State Measures, promoted by FAO and demanded by the sector for years; the launch of the campaign #MedFish4Eve to reverse the situation in the Mediterranean by the European Commission,...

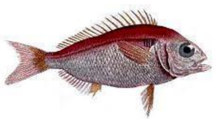
It is in this sense that this work will be carried out in the context of the European project PANDORA (PAradigm for Novel Dynamic Oceanic Resource Assessments[1]) in the Spanish Mediterranean.

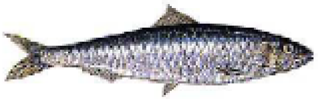
The general objectives of this study were to (i) analyse and assess the current bio-economic situation of the Spanish Mediterranean fishing fleet and (ii) to create more realistic projections of changes in economic factors and changes in fishing resources to ensure the long-term sustainability of fish stocks (Maximum sustainable yield “MSY” and Maximum economic yield “MEY”). As well as, the specific objectives were to (i) clarify the trade-offs between profitability and the number of jobs in their fishing fleets and (ii) to provide recommendations on how to stabilize the long-term profitability of the Spanish and the EU fisheries in general in order to contribute to the sustainable, ecological and economic exploitation of fish stocks in the Mediterranean.

This work is divided into three chapters. The first chapter is dedicated to present the methodological approach of the work, the second will deal with zone of study according to a bioeconomic and financial analysis and present the various results obtained. Finally, the last chapter will focus on the presentation of recommendations on how to stabilize the long-term profitability of Spanish and EU fishing in general in order to contribute to the sustainable, ecological and economic exploitation of fish stocks in the Mediterranean.

[1]: *https://www.pandora-fisheries-project.eu/*

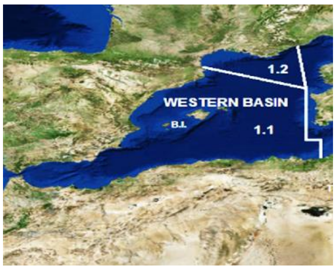
Table 2: Stock status in the Spanish Mediterranean (last assessment year 2016 by Froese compared to FMSY)

Species	GSA	Year	F/Fmsy	Effort Reduction
Anchovies (Engraulis encrasicolus) 	06	2013	1.5	0.34
		2014	2.037736	0.55
Hake (Merluccius merluccius) 	06	2013	7.8	0.87
	01	2012	7.4	0.86
	01	2014	7	1.2
	05	2013	7.7	0.87
Blackspot seabream 	01	2011	1.7	0.42
Blue and red shrimp 	01	2013	2.0	0.50
	05	2012	4.3	0.77
	06	2013	2.0	0.50
Deepwater pink shrimp (P. longirostris)	05	2012	1.2	0.17
	06	2012	5.5	0.82

		01 (with GSA 03 and 04)	2011	2.4	0.58
Norway lobster		05	2011	3.2	0.69
Red mullet		05	2012	6.6	0.85
		06	2013	1.3	0.23
Sardine (Sardina pilchardus)		01	2012	0.7	
			2014	1.176471	0.09
		06	2013	0.5	
			2014	2.142857	0.24
Stripped red mullet (Mullus surmuletus)		05	2013	3.0	0.67

Source: (Froese, 2016)

Chapter I: Methodology and Data Collection



Including to the Western Mediterranean subarea 37.1, our study area is defined in terms of FAO zoning as the Balearic zone, known by division 37.1.1 and by GSA01, GSA05 and GSA 06 according to the General Fisheries Commission for the Mediterranean (GFCM) zoning.

1. Data Collection

The data used to elaborate the various analyses contained in the report were obtained within the framework of the DCF (The Data Collection Framework: https://datacollection.jrc.ec.europa.eu) transversal and economic data for the years 2008 to 2017 (Data Call 2018).

In brief, the Data Collection Framework (DCF) is the reference framework established by the European Commission for the collection of fisheries data provided by member states. For 2017, the existing data in the 2018 Data Call are incomplete, but could be completed using formulas extracted from the Annual Economic Report produced by the EC (AER 2018, appendices). The capacity data series extends from 2008 to 2017, but the economic and labour data series are only up to 2016.

On the use of these data, indicators were calculated to evaluate the economic performance of the fleet segments, following the methodology of Sabatella and Franquesa (2004).

In order to eliminate distortions from inflation over a given period of time, all nominal values were converted to real values before estimating the indicators.

- **<u>Preliminary analysis of the disaggregated data</u>**

Depending on the country, the classification of fishing units is usually different, despite the existence of an official cataloguing under DCF (http://stecf.jrc.ec.europa.eu , AER 2018). This mainly affects the fleet segments that we consider artisanal. This may be related, depending on the case, to the type of gear used mainly or to the target species, or to the method of fishing (distinction between inshore/small scale and deep-sea fishing, or between artisanal, traditional and industrial fishing).

In order to allow aggregation of these data, a classification has been adopted that is based mainly on length group (distinction between small-scale fisheries/industrial fishing) and on main to fishing techniques. However, due to lack of data and the little consistency of the economic data disaggregated by length class, the classification within the group of small-scale gears is done at the level of the "VESSEL LENGTH" as illustrated in table 3. It is important to note that in area 37 most of the catches in volume and value come from DTS and PS, so it is less important to estimate the detailed parameters for the smaller gears.

This classification makes it possible to distinguish the following groups:

- DTS "Bottom trawling (industrial)": targeting demersal resources
- PS "Purse seine fishing (industrial)": aimed mainly at small pelagic
- Small-scale fishing: For area 37, most vessels are classified as DFN (nets), long-liners (HOK) or PGP (multipurpose), but not consistently year after year.

Table 3: Number of vessels by length group and fishing technique

Vessel length	DTS (Trawlers)	PS (Purse seiners)	Small-scale
VL0006	-	-	N = 168
VL0612	N = 24	N = 24	N = 1224
VL1218	N = 171	N = 100	N = 251
VL1824	N = 370	N = 95	N = 23
VL2440	N = 158	N = 22	N = 11
VL40XX	-	N = 2	-
Total	723	243	1677

- **<u>Extraction of necessary data from the STECF database</u>**

For each table of the STECF socio-economic database, the data extracted for Area 37.1.1 in this work are indicated in table 4.

Table 4: Data extracted for the area of study

Variable group	Variables
Capacity	▪ Total Number of Vessels, Vessel Tonnage (t), Vessel Power (kW), Average Vessel Length (m), Average Vessel Age (yr)
Capital	▪ Fishing rights (€), Tangible asset value (replacement) (€), Financial position (%), Investment (Capital value) (€)
Effort	▪ Days at sea, Fishing days, Maximum Days at Sea, GT fishing days, kW fishing days, Energy consumption (l)
Employment	▪ Total Employed, Full-Time Equivalent Harmonised (FTE-h)
Expenditure	▪ Other non-variable costs (€), Other variable costs (€), Rights costs (€), Energy costs (€), Wages and salaries of crew (€), Repair & maintenance costs (€), Annual depreciation costs (€), Unpaid labour value (€)
Income	▪ Income from landings (€), Income from leasing fishing rights (€), Direct income subsidies (€), Other income (€)
Landings FAO	▪ Value of landings (€), Live weight of landings (t) ⇨ **obtained from FAO FishStat 3.04.8 (July 2018)**

- **Several data related to the general economic indicators of the member state**

✓ Consumer Price Index (CPI) series: this parameter allows the conversion of nominal values to real values that will be applied later in the calculation of some parameters.

$$Real\ value\ i = \frac{Nominal\ value\ i}{\frac{CPIi}{CPIj}}$$

Where:

- **i** represents the year in which the nominal value is converted into the real value of 2015 and
- **j** the CPI reference year

In our case, we consider the year 2015 as the reference year for the change of the CPI 2015=100. Therefore, all values in this report are given in real euros of 2015, instead of in nominal euros.

✓ Series of Average annual percentage change (%) HICP-Rate of inflation and nominal interest: these parameters are required for the calculation of real interest as follows:

$$r = [(1+ i) / (1+n)] - 1$$

Where i: the nominal interest rate (http://www.ecb.int/stats/money/long/html/index.en.html) and n the rate of inflation (http://epp.eurostat.ec.europa.eu/page/portal/hicp/data/main_tables)

✓ Fuel price series over many years: this parameter allows specifying the variation of fuel costs that are considered the most important factor for the evaluation of profitability.

✓ Historical information on species harvested by time period: allows comparison of the state of the stocks between years and more realistic assessments and projections of changes in fishery resources: FAO FishStat, GFCM database.

2. Background on Economic Terminology & Definitions

- **Total Revenue**

The value of production (sale of landed fish and shellfish products) and income generated by the use of the vessel in other non-commercial fishing activities, such as recreational fishing, transport, tourism, oilrig rights, research, etc., may also include insurance payment for damage/loss of gear/vessel. It indicates the total profits obtained by the whole of the vessel owners.

$$Revenue = Income\ from\ landings + other\ income$$

In the Spanish Mediterranean fishing companies, the total income is practically equal to the value of the landings, since the incomes due to other activities (fishing tourism, boat rental, etc.) are negligible. That, they depend on the quantity landed, the species' price; the quantity and the species caught depend on the technology, its use (fishing effort) and the abundance, the price depends in general:

- Supply (more product, lower price) and Demand (with more consumers, higher price)
- Added value: Better presentation, Better quality (contamination, freshness), market differentiation

- **Tangible Asset Value**

It is the total of the capital invested in a boat at a certain time (tangible value). There are several possible capital estimators: sale value; replacement value; declared value in insurance, etc. The value of the physical means of production (boat, fishing gear, electronics, etc.) constitutes the fixed asset value (or "tangible asset value") and is considered here as an indicator of the Capital variable.

- **Gross Value Added (GVA)**

It is considered as the net output of a sector after deducting intermediate inputs from all products. It is a measure of the contribution to GDP made by an individual producer, an industry or a sector. In the fishing enterprise, it expresses the Added Value that the segment in question contributes to the National Economy. This includes: salaries, profits, opportunity cost and depreciations. This amount is distributed between the gross profit of the company, the amortization of the capital and the remuneration of the work employed in fishing. Also, the GVA can be expressed per employee as an indicator that allows comparisons with other sectors of the economy.

GVA = Income from landings + other income – energy costs – repair costs – other variable costs – non variable costs

- **Gross Cash Flow (GCF)**

As an indicator it shows how much is available for interest payments, loan repayments, offsetting depreciation (internal investment) and repaying invested capital (opportunity cost). It is considered as the value of landings after all expenditure, except depreciation and interest:

GCF= Income from landings + other income – crew costs – unpaid labour - energy costs – repair and maintenance costs – other variable costs – non variable costs

- **Net Profit (NP): Profitability**

It is the balance that most interests the entrepreneur, although Boncoeur et al. (2000) and Maynou et al. (2012) consider that for decision making, the fisher-owner of small units in the Mediterranean usually considers the Gross Profit only, since in small enterprises the profit of the enterprise and the remuneration of the owner-employer are confused. It would provide a direct comparison with returns available elsewhere in the economy. The total earnings obtained by the whole of the owners, once the depreciation cost has been deducted (Sabatella y Franquesa, 2017).

Net Profit = Income from landings + other income – crew costs – unpaid labour - energy costs – repair costs – other variable costs – non variable costs – depreciation cost – opportunity cost of capital

- Opportunity Cost of Capital = fixed tangible asset value * real interest
- Real Interest (r) = [(1 + i)/ (1 + j)] -1

Where (i) is the nominal interest rate and (j) is the inflation rate of the Member State in the year in question.

Table 5: Inflation and interest rate for Spain during the period 2008-2017 (STECF, 2018)

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
i	4.37	3.98	4.25	5.44	5.85	4.56	2.72	1.73	1.39	1.56
j	4.1	-0.22	2	3.1	2.4	1.5	-0.2	-0.6	-0.3	2.0
r	0.05	5.38	0.75	0.57	1.01	1.22	3.65	5.82	2.41	-0.14

- **Return on Fixed Tangible Assets (RoFTA)**

It measures the long-term economic profitability of the sector. It compares the profits obtained through the investment made with the profits that would have been obtained if it had been invested at a long-term risk-free interest rate (TRP). Where the interest-rate risk-free is defined as the zero risk rate or risk-free rate, it is a theoretical concept that assumes that in the economy there is an investment alternative that has no risk for the investor. This offers a safe return in a monetary unit and in a determined term, where there is no credit risk or reinvestment risk since, once the period has expired, the cash will be available.

To calculate it, the interest rate of the ten-year government bonds with convergence criteria, obtained from the statistical bulletin of the Spanish Central Banks, are used as a comparison. In order to avoid fluctuations, mainly due to the economic crisis, instead of using the value of the bond in a given year, the arithmetic average of the five years prior to the year of study has been used.

RoFTA = [net profit/tangible asset value (vessel depreciated replacement value)]×100

The Tangible Asset Value can be estimated in two different approaches; Tangible asset value (replacement value) which indicates the value of the boat today after maintenance, depreciation, etc. and tangible asset value (historical) is the historical value of the boat "how much the boat is worth at the time of purchase". Here we will use the first definition, the replacement value, as an approximation to the value of fixed assets or capital.

- **Return on Investment (RoI)**

In economic analysis of fisheries, due to the difficulty of accurately estimating the capital of the company, the ROFTA is used as an approximation of ROI. Where ROI measures the profitability of a sector in relation to its total assets. The purpose of ROI indicator is to measure, per period, rates of return on money invested in an economic entity to decide whether to undertake an investment. It measures the financial profit at full equity as a percentage of total capital for the average vessel in a fishery.

The ROI compares the long-term profitability of the fishing fleet segment to other available investments. A value less than zero or smaller than the low risk long term interest rates available elsewhere, is an indication of long-term economic inefficiency and overcapitalization.

$$\text{ROI} = [\text{Net Profit}/\text{Capital Asset Value}] \times 100$$

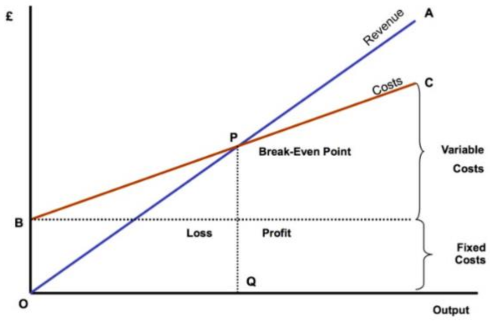
Where the Capital Asset Value will be calculate: vessel depreciated replacement value + estimated value of fishing rights.

So it was classified as High, Reasonable or Weak according to the criteria;

ROFTA > 10%	High	Profitability is good and segment is generating a good amount of intra-marginal profits
0≤ROFTA≤10%	Reasonable	Segment is profitable generating some intra-marginal rents
ROFTA ≤ 0	Weak	The segment is making losses; economic overcapacity

- ## <u>Break-even revenue</u>

In economics, the Break-even point (BEP) or break-even level is the point at which total cost and total revenue are equal. It represents the minimum number of units that a company needs to sell in order for the profit at that time to be zero. In other words, this point represents the sales amount, in either unit (quantity) or revenue (sales) terms, that is required to cover total costs, consisting of both fixed and variable costs to the company. Total profit at the break-even point is zero (Garrison, 2011). For the fishing enterprise, it is only possible to pass the break-even point if the euro value of sales is higher than the variable cost per unit. This means that the selling price of the landing must be higher than what the company paid for it or its components for them to cover the initial price they paid, variable (Crew wages and salaries, replacement, repair and maintenance costs of the vessel, energy costs…) and fixed (Annual depreciation or amortization, rental of machinery or equipment…) costs. Once the company surpass the break-even price, it starts making a profit.



- **Revenue to Break-even revenue Ratio (CR/BER)**

The CR/BER is a measure of the short-term economic profitability of the fleet or fleet segment (or over/under capitalised). It compares current revenue (CR) with break-even revenue (BER), which is the revenue needed to cover the fixed and variable costs incurred to carry out the activity.

If CR/BER is greater than one, sufficient revenue has been generated to cover the costs. In other words, a sufficient cash flow is generated to cover the fixed costs (economically viable in the short term). When the indicator is higher, the sector will be more profitable

If the indicator is less than one, the fleet or the fleet segment is not economically sustainable, as it will not be able to cover the costs incurred with the income obtained. In this case, there is insufficient cash flow to cover fixed costs (indicating that the segment is economically unviable in the short and medium term).

The cases in which the result is a **negative indicator** are due to the fact that the variable costs have exceeded the revenue obtained.

It has been obtained for the period 2008-2016, and its calculation was made as follows:

CR/BER = revenue / break-even revenue = Income from landings + other income / BER

CR = Current revenue = Revenue from fishing activity + other operating revenue of the vessel

BER = Fixed Costs / (1- (Variable Costs/Current Income))

Being;

$$\textbf{fixed costs} = \textbf{Depreciation} + \textbf{Non} - \textbf{variable costs} + \textbf{Opportunity costs}$$

In order to calculate it, the opportunity of the capital cost is omitted, since if it is included, the long-term profitability would be evaluated, a profitability that is already evaluated with ROFTA.

$$\textbf{Variable costs} = \textbf{Crew wages and salaries} + \textbf{Unpaid work} + \textbf{Repair and maintenance costs} + \textbf{Energy costs} + \textbf{Other variable costs}$$

The main variables used to calculate this indicator are summarized in appendix 1.a

- **Average Gross Wage per FTE**

It calculates the average wage of a full-time worker in a fleet segment. This indicator can provide useful information on the variability of crewmembers' incomes. It includes both wages and salaries of crew and the value of unpaid work.

$$\textbf{Average gross wage per FTE} = \frac{\textbf{Total staffcosts}}{\textbf{FTE (National)}}$$

Being;

- Total staff costs = crew wages and salaries + imputed value of unpaid work
- FTE is the unit of work performed by a full-time person over the period of one year.

We do not have data on crew or unpaid work for some years. Nevertheless, in order to avoid affecting the calculation of social indicators, we use the average between the previous year and the year that follows the said year. On the other hand, for the analysis of this indicator, we make a comparison of the value obtained with the average inter-professional wage (el salario medio interprofesional) SMI (http://www.mitramiss.gob.es/) and with the average annual wage (el salario medio annual) SMA (https://www.ine.es/) which gives an overview of the standard of living of fishers and workers in the sector.

We consider the fleet in a precarious situation when the average wage per annual work unit is lower than the national SMI while a favorable situation is considered if it is higher than the national SMA is. It provides an overview of the standard of living of workers in the sector. Fleets whose average annual wage per work unit is lower than the national SMI are considered to be in a precarious situation.

- **Labour Productivity GVA/FTE**

Labour productivity, defined as gross value added per FTE (GVA/FTE), gives an indication of the economic growth in the sector, while capital productivity measures profit per unit of capital invested. The GVA/FTE represents the value added, or unit produced per worker, "the output of a sector", i.e. the approximate contribution to the sector per full-time employee after deducting intermediate inputs from all products. It is therefore a measure of the competitiveness of the sector. It can also be understood as an indicator of the worker's standard of living or social well-being if it is verified that an increase in productivity is accompanied by wage increases. An increase in its value may be due to two main circumstances, or a combination of both:

- By maintaining the number of FTE workers, there is an increase in income and/or a decrease in production costs.
- With both income and costs remaining stable, the number of workers decreases.

From an economic point of view, both options are considered valid. However from a social point of view, the fact that a company increases its profits at the expense of reducing the number of employees implies an increase in work pressure on employees, who must make a greater effort (due to the decrease in hired personnel) to obtain the same benefit. Therefore, the study of this indicator, as well as its evolution, should be carried out with caution, analysing the FTE value in parallel.

In the fishing enterprise, it is calculated: the value of landings minus the cost of inputs. This amount is distributed between the capital and the work employed in fishing. It is the sum of labour costs, depreciation, interest and net profit.

FTE is the unit of work performed by a full-time person throughout the year.

- **GVA per Vessel**

This indicator is very similar to the previous indicator Labour Productivity but instead of obtaining the value added per full-time employee it is obtained per vessel.

3. Economic & Social Indicators

From the data submitted by Member States in the Framework Data Collection as we said before, indicators were calculated in order to assess the economic performance of fleet segments. However, due to the lack of data provided by the Spanish State, that only transmit data on landings (value and weight) and effort (days at sea, fishing days, etc.) at sub-region level by fleet segment, we cannot collect the fleet economic data with a greatest accuracy. Therefore, basing on the methodology of AER, we consider that the correlation with transversal data is the only viable way for disaggregating economic data and to complete the series of data (STECF, 2018).

➢ To complete the series of years with missing data

- Crew wages (CW) and unpaid labour costs (ULab) were calculated using the average wage crew/days at sea (DAS) ratios over the previous three years:

Crew wages: $$CW_t = \frac{\sum_{t-1}^{t-3} CW}{\sum_{t-1}^{t-3} DAS} \times DAS_t$$

Unpaid labour costs: $$ULab_t = \frac{\sum_{t-1}^{t-3} ULab}{\sum_{t-1}^{t-3} DAS} \times DAS_t$$

- When days at sea are not available, crew wages (CW) were estimated as an average proportion of the value of the landing (VaL) over the previous three years:

Crew wages: $$CW_t = \frac{\sum_{t-1}^{t-3} CW}{\sum_{t-1}^{t-3} VaL} \times VaL_t$$

- Correlation based on the change in capacity, with N is Number of Vessels

Non-variable costs: $$NVC_t = \frac{NVC\ t-1}{N\ t-1} \times Nt$$

Total employed: $$JOB_t = \frac{JOBt-1}{N\ t-1} \times Nt$$

Other Income: $$OInc_t = \frac{OInc\ t-1}{N\ t-1} \times Nt$$

Annual depreciation: $$DEP_t = \frac{DEP\ t-1}{N\ t-1} \times Nt$$

Fleet depreciated replacement value: $$REP_t = \frac{REP\ t-1}{N\ t-1} \times Nt$$

- Correlation based on the effort change, Days at Sea (DAS)

Variable costs: $$\mathbf{VC_t = \frac{VC\ t-1}{DASt-1} \times DAS_t}$$

FTE: $$FTE_t = \frac{FTE\ t-1}{DASt-1} \times DAS_t$$

Repair & Maintenance costs: $$RMC_t = \frac{RMCt-1}{DASt-1} \times DAS_t$$

Fuel consumption: $$FCon_t = \frac{FCon\ t-1}{DASt-1} \times DAS$$

- Correlation based on Days at Sea and Fuel Price (P):

Fuel Costs: $$\mathbf{FC_t = \frac{FC\ t-1}{DAS\ t-1} \times DAS_t \times \frac{P\ t}{P\ t-1}}$$

- **<u>Disaggregation of economic data</u>**

Transversal and economic data by fleet segment were disaggregated based on either the number of active vessels in a region, value of landings or effort (days at sea), as:

Number of vessels in region (NReg)	Used to estimate fleet capacity, non-variable costs and capital costs (annual depreciation and opportunity costs of capital)
Value of landings (VaL)	Used to allocate income from landings
Effort in days at sea (DAS)	Used to allocate all variable costs, including labour, energy, repair and maintenance, and fuel consumption. DAS was also used to estimate the number of vessels when NReg was not available.

In cases where N_{Reg} was not available, the estimated number of vessels in the region (N_{Reg*}) was calculated based on DAS and using the total number of vessels (N_{tot}), as:

$$N_{Reg*} = \frac{DASReg}{\sum DASReg} \times N_{tot}$$

- ✓ **Variables disaggregated with N_{Reg}**

Variables	N_{Reg} is given	N_{Reg} is missing
Gross tonnage (GT)	$GT_{reg} = \frac{N_{Reg}}{\sum N_{Reg}} \times GT_{Tot}$	$GT_{reg} = \frac{GT_{Tot}}{N_{Tot}} \times N_{Reg*}$
Engine power (kW)	$kW_{Reg} = \frac{N_{Reg}}{\sum N_{Reg}} \times kW_{Tot}$	$kW_{reg} = \frac{kW_{Tot}}{N_{Tot}} \times N_{Reg*}$
Total employed (JOB)	$JOB_{reg} = \frac{N_{Reg}}{\sum N_{Reg}} \times JOB_{Tot}$	$JOB_{Reg}(OInc) = \frac{N_{Reg*}}{N_{Tot}} \times JOB_{tot}$

Other income	$(OInc) = \frac{N_{Reg}}{\sum N_{Reg}} \times OInc_{tot}$	$(OInc) = \frac{N_{Reg^*}}{N_{Tot}} \times OInc_{tot}$
Opportunity cost of capital	$(OPC) = \frac{N_{Reg}}{\sum N_{Reg}} \times OPC_{tot}$	$(OPC) = \frac{N_{Reg^*}}{N_{Tot}} \times OPC_{tot}$
Annual Depreciation costs	$(DEP) = \frac{N_{Reg}}{\sum N_{Reg}} \times DEP_{tot}$	$(DEP) = \frac{N_{Reg^*}}{N_{Tot}} \times DEP_{tot}$

✓ **Variables disaggregated with VaL: Income from landings**

$$Landings\ \ Income_{Reg}(LInc) = \frac{VAL_{Reg}}{\sum VAL_{Reg}} \times LInc_{Tot} \qquad Landings\ \ Income_{Reg}(LInc) = \frac{VAL_{Reg}}{VAL_{Tot}} \times LInc_{Tot}$$

✓ **Variables disaggregated with DAS: Days At Sea**

Crew wages	$CW_{reg} = \frac{DAS_{Reg}}{\sum DAS_{Reg}} \times CW_{Tot}$
Unpaid labour costs	$ULab_{reg} = \frac{DAS_{Reg}}{\sum DAS_{Reg}} \times ULab_{Tot}$
Fuel costs	$FC_{reg} = \frac{DAS_{Reg}}{\sum DAS_{Reg}} \times FC_{Tot}$
Repair costs	$REP_{reg} = \frac{DAS_{Reg}}{\sum DAS_{Reg}} \times REP_{Tot}$
Other variable costs	$VAR_{reg} = \frac{DAS_{Reg}}{\sum DAS_{Reg}} \times VAR_{Tot}$
Fuel consumption	$FCon_{reg} = \frac{DAS_{Reg}}{\sum DAS_{Reg}} \times FCon_{Tot}$

Full Time Equivalent (FTE)	$FTE_{reg} = \dfrac{DAS_{\mathrm{Reg}}}{\sum DAS_{\mathrm{Reg}}} \times FTE_{Tot}$

4. Data & Limitations

Currently, the main source of economic data on the fishing fleet at the EU level is the data collected under the DCF and requested from MS through a data call issued annually by the European Commission (DG MARE). The JRC serves the data call, houses the DCF databases and provides quality checked data to STECF expert working groups. In the case of the Spanish fleet, due to non-submission or submission of incomplete datasets by the State creates difficulties in estimating parameters and indicators.

The indicators and the estimated parameters in this work are based on DCF submitted data and the results obtained through the surveys with fishers. They should be treated with care when drawing general conclusions about the structure and economic performance of the Spanish fleet operating in the study area.

- Additionally, data limitations arise when the Spanish fleet is analysed at the level of fishing gear. For this reason, we use the data provided by fleet segment level to analyse. When evaluating the economic performance several key variables are required. Without these key elements, performance indicators cannot be calculated. A brief outline of the main data limitations includes:

- **Value of landings:**

Not all the years had data on the value of landings. Therefore, it was not possible to assess the total value of landings at the fleet level. Furthermore, even Spain submitted data on the value of landings at the national level; the homologous data is not always complete at the fleet segment level.

- **Other Income**

Income includes not only the value of landings, but also income generated from other non-fishing activities, from leasing out fishing rights and direct income subsidies. As with the value of landings, not all the year had data on income. Therefore, it is not possible to quantify the exact level of income generated by the fleet or the fleet segment

- **Gross Value Added (GVA) and Gross Profit**

These indicators are calculated using income and costs data submitted by Member States. In order to calculate GVA, data on income, energy costs, variable costs, repair costs and non-variable costs are required. If Member States did not submit any one of these DCF parameters, the calculation of GVA was not possible. In order to calculate gross profit, crew costs are also required, in addition to the costs required to calculate GVA.

As with GVA, if Spain did not submit any one of these DCF parameters, the calculation of gross profit was not possible. Therefore, similar to the other economic indicators, it was not possible to quantify the exact level of GVA or gross profit generated by the fleet.

- **Net Profit / Loss**

Similar to GVA and gross profit, this indicator is calculated using income and costs data submitted by Member States. In order to calculate net profit/loss, data on income, energy costs, variable costs, repair costs, non-variable costs and capital costs (depreciation and opportunity costs of capital) are required. In this case, if Spain did not submit any one of these parameters, in particular capital costs, the calculation of net profit/loss is not possible.

Chapter II: Results & Analysis

1. Landings by species

More details on landings and values generated by fleet segment can be found in figures appendix 1.b.

1.1. The Trawler Fleet

As illustrated in the figure 2 (a and b), on average the segment 06-12m and the segment 12-18m produced respectively 327 tonnes and 4630 tonnes and generated 1.29 and 20 million euros during 2008-2017. Targeted especially to Finfishes (FIN), Common octopus (OCC) and Red mullet (MUT). However, the segment 18-24m and the segment 24-40m, produced around 50% of the total landings of the trawler fleet with 12913 tonnes and 6801 tonnes respectively. And generating around 70 million euros and 11 million euros, on average the period between 2008 and 2017. Dedicating especially to European hake (HKE), Blue and red shrimp (ARA), Deep-water rose shrimp (DPS) and Norway lobster (NEP).

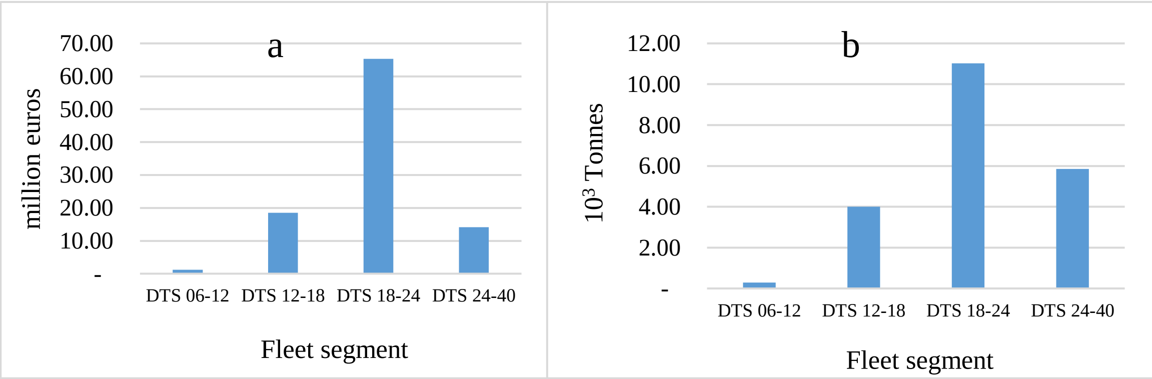


Figure 2: Trawler fleet (a): Value of landings by fleet segment, (b): Live weight of landings by fleet segment

1.2. The Purse seine Fleet

On average the period of study, the majority of landings and value generated are coming from the segment 18-24m and the segment 12-18m (see figure 3) with respectively 49% and 27% in terms of live weight landed and with 47% and 34% in terms of value obtained. While, the segment 06-12m and 24-40m contributed with 3% and 22% of total purse seine production and with 3% and 12% of total value.

As we said on the previous section, the purse seine fleet is targeted especially to species with pelagic behavior. Where, the majority of its landings and values generated come from Sardine (PIL) and Anchovy (ANE). However, the contribution in live weight and value of landings of Atlantic bonito (BON), Round sardinella (SAA), Atlantic mackerel (MAC), Mediterranean horse mackerel (HMM) and Atlantic horse mackerel (HOM) is considered negligible.

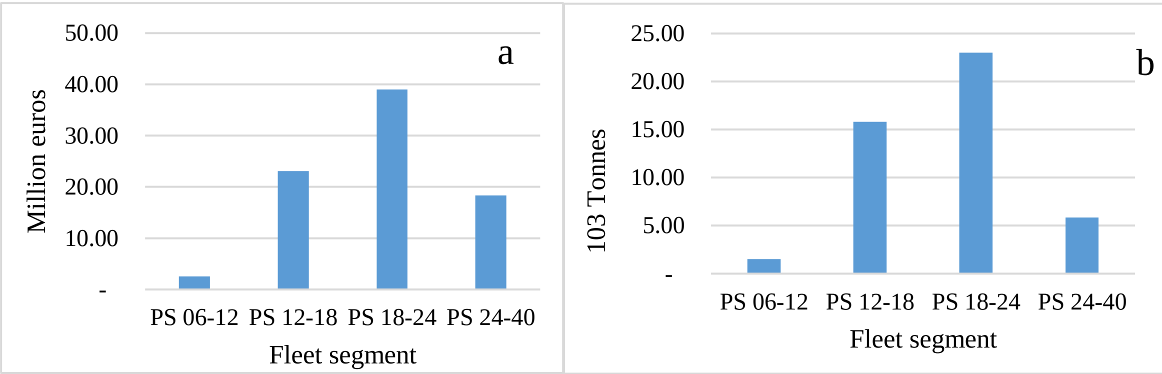


Figure 3: Purse seine fleet; (a): value of landings generated by fleet segment, (b): Live of landings by fleet segment

1.3. The Small-scale Fleet

In comparison with the live weight landed and the value generated by the two previous fleets, landings and value in the case of the small-scale fleet are considered insignificant. Where the majority of its production come from the segment 06-12m and 12-18m (see figure 4) with a contribution respectively around 51% and 23% in terms of landings and with 47% and 25% in terms of value generated. In contrast to trawlers and purse seiners, which are dedicated correspondingly to demersal and pelagic stocks, the artisanal fleet practice a mixed and multi-species fishery. Dedicating to Common octopus (OCC), Tuberculate cockle (KTT), Common cuttlefish (CTC), Swordfish (SWO), European hake (HKE), Atlantic horse mackerel (HOM), Norway lobster (NEP) and other species (for more details see appendix 1.b).

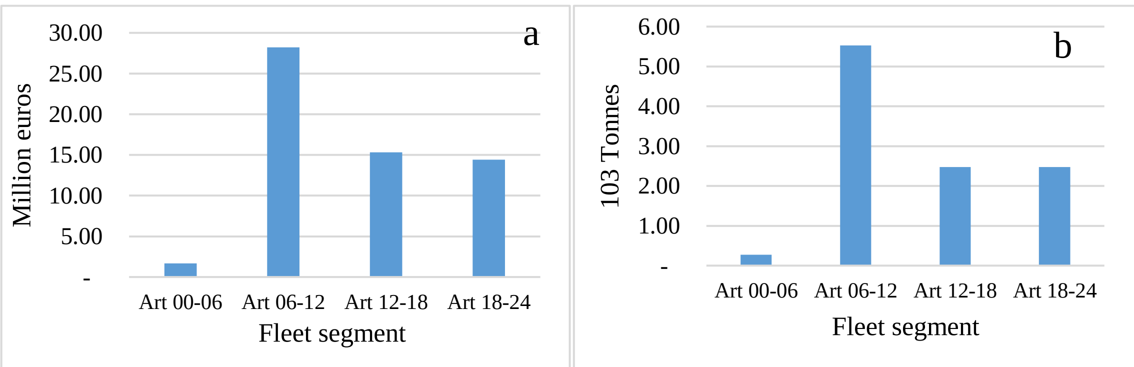


Figure 4: Small-scale fleet; (a): value generated by fleet segment, (b): live weight of landings by fleet segment

2. The Economic Indicators

The tables containing the results of Economic & Social indicators can be found in Appendix 1.c

2.1. Net Profit (NP) & Net Profit margin (%)

Economic profit is the main indicator of economic performance and is often used as an approximation of resource rent in fisheries. Also called supernormal or abnormal benefits. Abnormal profits in one sector encourage other companies to enter the industry (if they can). A zero or negative profit margin may indicate strong and high competition in the sector and can be used as one of the indicators of overcapacity.

Net profit margin (%): Economic profit margin - a measure of profitability after all costs have been accounted for, and **reflects the percentage of revenue that a sector retains as profit**. It measures the relative performance of the sector compared to other activities in the economy and provides an indication of the sector's operating efficiency as it captures the amount of surplus generated per unit of production.

- **The Trawler Fleet "DTS":**

According to the data providing at segment level, the amount of income (excluding direct income subsidies) generated by the Spanish Mediterranean trawler fleet in 2017 was 161 million euros. This consisted in just value of landings.

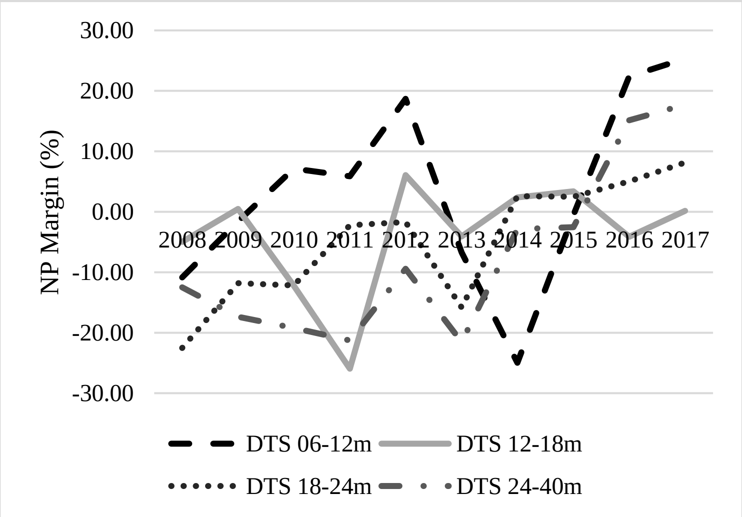


Figure 5: Net Profit margin generated by the Trawlers' segments

Total operating costs (including crews costs, energy costs, depreciation costs, other variable costs, other non-variable costs, maintenance costs, and rights costs) incurred by the fleet equated to 137 million euros, amounting to 85.26% of total income. Crew costs and energy costs, the two major fishing expenses, were 56 million euros and €31 million euros respectively, amounting to 54.3% of total income.

In term of economic performance, the amount of Gross value added (GVA), Gross Profit (GRP) and Net Profit (NP) by the trawler fleet during 2017 was respectively: 89.77 million euros, 25.37 million euros and 16.23 million euros.

In order for fishing to be profitable, the value of the catch has to exceed the cost of fishing. Nevertheless, by the year 2014, the trawler fleet sustained a net operating loss, as well as the vessels was generating insufficient cash flow to cover expenses. As demonstrated in figure 5, all the segments of trawler fleet showed a decreasing trend in Net profit until 2014-2015 followed by an increase in the last 2-3 years, with the lowest profitability observed in segment 12-18m.

- **<u>The Purse seine Fleet "PS"</u>**

Considering only incomes of landings, the Purse seiners operating in the Spanish Mediterranean have generated 73.96 million of euros during 2017. Further, 60 million euros estimated the amount of total operating costs for the same year, amounting of 81.30% of total income. Representing 52.23% of total income, the crew costs was around 38 million euros. Furthermore, the energy costs around 5 million euros which amounting 6.88% of the fleet' total incomes. The amount of Gross value added (GVA), Gross Profit (GRP) and Net profit (NP) generated by the Purse seine in the area 37 during the same year was respectively: 53, 11 and 5 million euros. Representing respectively 72%, 16 % and 7% of total incomes generated.

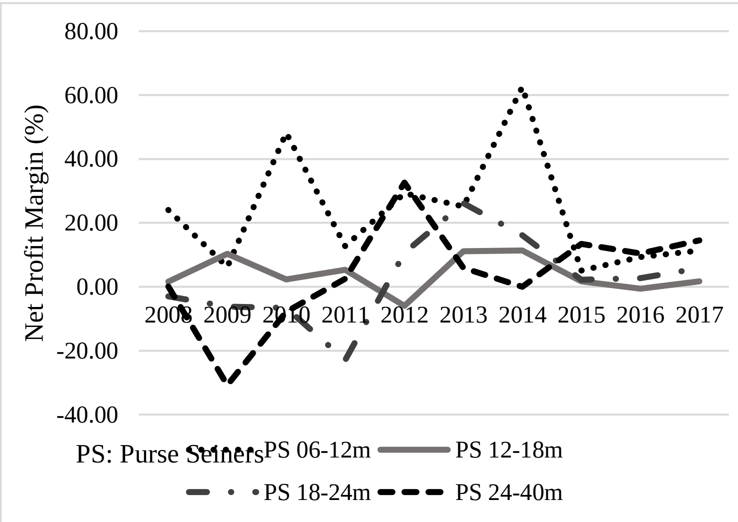


Figure 6: Net Profit margin generated by the purse seiners' segments

In comparison with the trawler fleet, the purse seiners had a viable economy. That in 2017, its net profit margin was estimated around 33.41%. All the segments have showed a positive NP at some point since 2012 achieving a maximum in 2012-2013. However, after the year in question, the seiners above 18m reflected an overcapacity demonstrated by the negative trend of its profitability (see figure 6).

- **<u>The Small-scale Fleet "Artes Menores":</u>**

Contributing with €91 million of incomes, the small-scale gears represents 68.16% of the vessels operating in the Spanish Mediterranean. Amounting to 56.51% of total income, total operating costs incurred by the fleet equated to 51 million euros during 2017. Crew costs and energy costs were 24 million euros and 3 million euros, as well as representing respectively 26% and 3% of total income.

In terms of economic performance, during the same year, the small-scale fleet operating in area 37 generated 66 million euros, 27 million euros and 23 million euros respectively of Gross value added (GVA), Gross profit (GRP) and Net profit (NP).

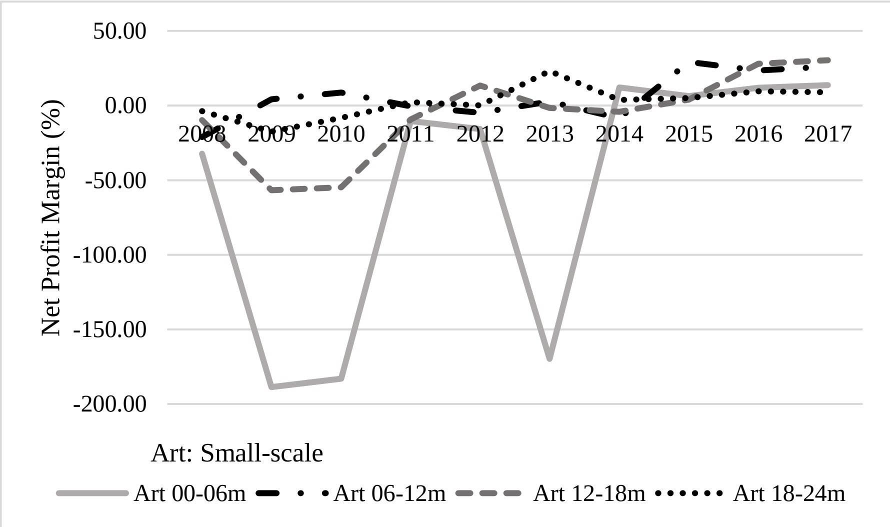


Figure 7: Net Profit Margin generated by Small-scale's segments

The Net profit of small-scale fleet across the four segments showed a similar pattern for the trawler fleet with a negatives values obtained during the period before 2014 (see figure 7). An increase in Net profit was observed in the last 3 years of the period under analysis with the lowest profitability is observed in vessels below 6m.

2.2. Revenue to Break-even revenue ratio CR/BER

- **<u>The Trawler Fleet</u>**

Similar to the trend of profitability at short term, the trend in CR/BER started to improve since 2014, where an increase is observed for all segments in the last 3-4 years. However, before the year in question, trawler above 18m showed an inefficient and unviable economy. Reflecting by the values of its indicator that did not reaching one (CR/BER<1) during all the period. Further, the heavy dependence on overexploited stocks and on high-risk species such as Norway lobster (NEP), red shrimp (ARA) and rose shrimp (DPS), European hake (HKE) and red mullet (MUT), accentuated the unbalance of economic situation of segments above 18m.

- **The Purse seine Fleet**

Over the last ten years, the European Union's supply of sardines has changed significantly. Between 2004 and 2014, with the exception of Croatia (+241% in volume) and Italy (+116%), most of the main European Union countries involved in sardine fishing experienced a fall in landings, mainly in Portugal (-79%), Spain (-30%) and, to a lesser extent, France (-19%) and Greece (-9%). The main causes are the decline in sardine populations in the South Atlantic and Western Mediterranean. In terms of fisheries management, stocks are not managed by European Union TACs. However, in the southern part, stocks are managed by technical measures and limits on fishing effort and catches (EUMOFA, 2016).

In the case of the Spanish Mediterranean, sardine and anchovy stocks form the basis of commercially important fisheries that form the mainly exploited and target species by the purse seine fleet. In both zones GSA 06 and GSA 01, they represent the two main species caught for these fleets. Nevertheless, low abundance, reduced geographic distributions and low yields, in other words the decline in sardine stocks does not influence on the profitability of purse seiners. Six consecutive years of good profitability of this fleet. Explained by the good amount of current revenue that exceeded the break-even point, for which the indicator of economic profitability is greater than one (CR>BER).

- **The Small-scale Fleet**

The trend in the indicator follows the pattern of the previous. That an improvement of the indicator was observed during the last three years. However, the period before 2014, all the segments showed an economic unviability reflecting with negative values experienced by the segment below 6m and an insufficient cash flow to cover the fixed costs in the case of the rest of segments (0<CR/BER<1).

2.3. Return on Fixed Tangible Assets "RoFTA"

- **<u>Trawler Fleet</u>**

Referring to the two previous indicators, the trawler fleet characterized by an economic overcapacity at the short and medium term where for the majority of its segments was unable to generate sufficient cash flow to cover its costs.

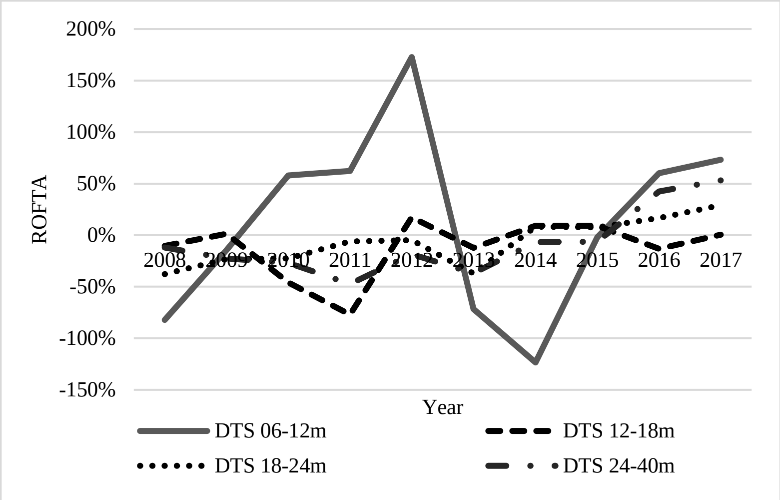


Figure 8: Rate of Return for the trawler fleet's segments

Regarding the profitability at long-term, all the segments showed a negative values of ROFTA, as illustrated in figure 8 until 2015, followed by an increasing during the last three years. With the lowest performance observed in the segment 12-18m.

- **<u>The Purse seine Fleet</u>**

83% of financial profit had been estimated at full equity as a percentage of total capital on average all the years of study, the purse seiners experienced a viable profitability in the long-term. Where all the segments showed an important increasing during the last 5-6 years.

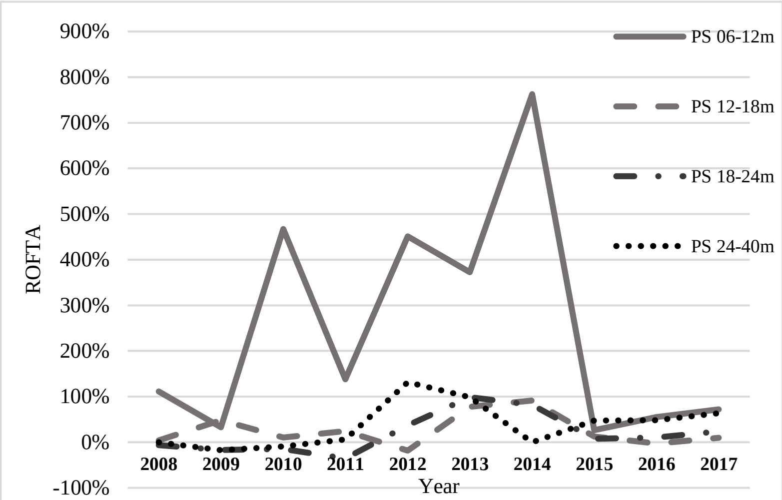


Figure 9: Rate of Return for Purse seiners' segments

As demonstrated in figure 9, the segments below 18m are considered more profitable than the big seiners. Where, the segment 18-24m and 24-40m experienced a negative values in some points during the period before 2012. Due to its dependence on the sardine stock especially in the zone GSA 06 and GSA 01, as it represents 10% of its catches.

- **The Small-scale Fleet**

Unable to generate a sufficient financial profit to cover its costs in long-term, as the previous indicator, all segments of artisanal fleet showed a negative trend of ROFTA until 2014, followed by an increasing in the last 3-4 years (see figure 10). The highest performance was observed for the segment 18-24m, where its profitability started to improve since 2011. While the segment under 6m experienced the lowest performance.

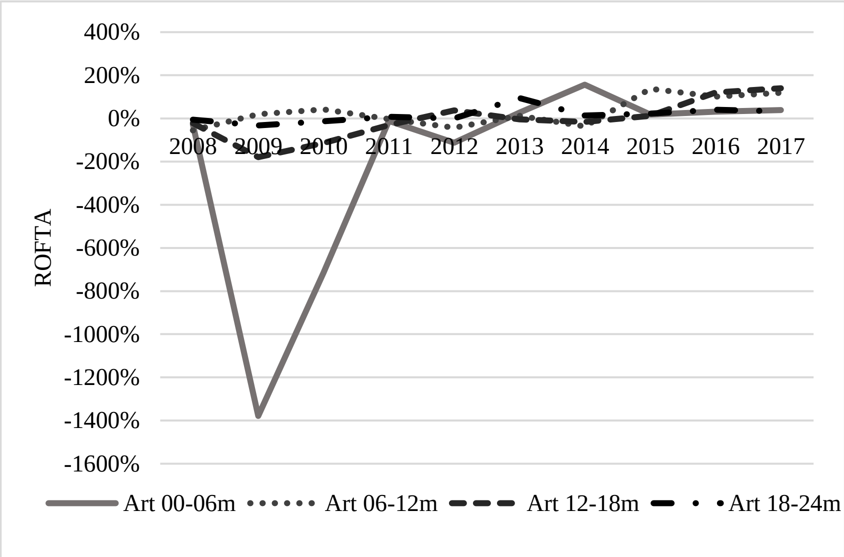


Figure 10: Rate of Return for the Small-scale's segments

3. The Social Indicators

The social indicators are aimed at verifying the evaluation of the social benefits of the fisheries sector, that they provide a means of showing variations in the income of fishers on board fishing vessels; they also make it possible to analyze and evaluate possible situations of imbalance.

3.1. Average Wage/FTE

The annual data established and published for the Ministry of Employment and Social Security in the case of SMI and for the National Statistics Institute in the case of SMA for the years of study can be founded in Appendix 1.c.

Across all the years of study, the standard of living of workers in the trawler fleet was considered non-hazardous. Where the average wage per annual work unit in all fleet segments was between the values of the average inter-professional wage “SMI” and the average annual wage “SMA”. While, the crewmembers of purse seiners experienced highest salaries than the previous ones.

In either case, fishers used to work in vessels above 24m are more advantageous and generated more profits. Where the average wage per annual work unit exceeded the SMA during all the year in the case of seiners of medium length 24-40m.

Regarding, the crewmembers operating in the artisanal vessels under 12m, the standard living was considered in precarious situation due to its economic unviability reflected by its lowest profitability in the previous section. However, workers in the segment 18-24m are more beneficial. Experienced a highest wage in comparison with the rest artisanal vessels.

3.2. Labour Productivity (GVA/FTE)

To evaluate the profitability of the fishing sector and the standard living of fishermen through these two indicators, we obtain the GVA/FTE ratio with the data obtained here for each fleet Segment. Besides compare, it with the same ratio (GVA/FTE) of the national data obtained both from the National Accounts published by the National Statistics Institute, presented in the table (Appendix1.c): (https://www.idescat.cat/indicadors/ y https://www.ine.es/). In this way, when the indicator is higher than that corresponding to national data, we can say that the fishing sector is more productive than the national average.

Regarding the Gross Value Added, the three fleets showed a decreasing trend of GVA until 2013-2014, followed by an increase in the last 3-4 years with the lowest values observed for the small-scale fleet (see figure 11). While, the full time equivalent (FTE) showed an important decrease during the last years. The decreasing in the number of workers, especially in the case of trawler fleet, can be explained by the professionalization of the fishing sector.

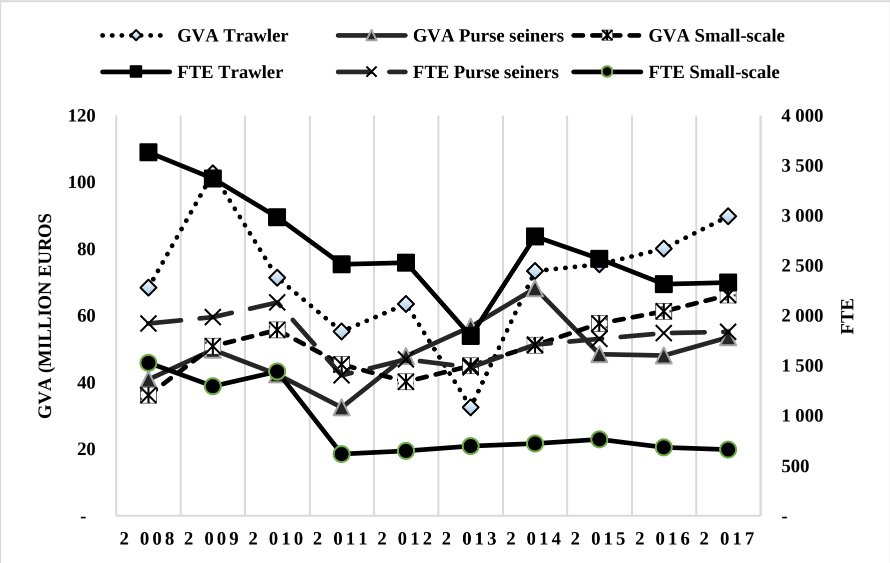


Figure 11: Trends of GVA & FTE for the three fleets

Across all the years, the trawlers and purse seiners showed values below the average GVA/FTE of fishing sector. Subsequently except of segments over 24m presented a favorable situation during 6 years of study. Where, purse seiners over 24m generated GVA/FTE higher than national ones. However, the unit produced by the small-scale fleet was above the fishing sector. Where segments 06-18m during the last 6-7 years, recorded values higher than the national average productivity.

3.3. GVA /Vessel

Across all the years of study, the trawlers under 18m were unable to achieve the average of fishing sector. While, segments above 18m showed important values. That exceeded the national average with 0.13% and 0.66% respectively for the segment 18-24m and 24-40m.

However, the unit produced by purse seiners' vessels showed an increasing. Compared to the national average, the unit produced by the segments 12-18m, 18-24m and 24-40m corresponding respectively to the double, the triple and fivefold the GVA/Vessel of the fishing sector. While, the segment 06-12, experienced a decreasing in its indicator during the last 4 years that was below the national average.

Regarding the small-scale fleet, the average unit produced per vessel under 18m does not reached the national value across all the years. Nonetheless, vessels over 18m showed a good productivity where the unit of production generated exceeded the national average.

4. Profitability at maximum sustainable yield (MSY)

The Marine Strategy Framework Directive (MSFD 2008) and the reformed Common Fisheries Policy of the European Union (CFP 2013) demand that fishing pressure (F) on stocks does not exceed the one (Fmsy) that can produce maximum sustainable yields (MSY), generally in 2015 and under special circumstances latest in 2020. In addition, the biomass (B) of stocks has to be rebuilt above the level (Bmsy) that can produce MSY (Froese, 2016).

Based in results of Froese's study in 2016 "Exploitation and status of European Stocks", in this part, only 15 stocks are targeted by the Spanish Mediterranean fleet and for which MSY levels are determined.

The purpose of this part was to evaluate and compare the level of exploitation of the target stocks (if the recent landings exceeded the maximum sustainable yield **"C/MSY > 1".**

Deeper, to examine the economic and social situations of the Spanish Mediterranean fleet if will operate at maximum sustainable yield (MSY). In other words, a comparison between two cases “the current indicators” and “the indicators can be provided at level of MSY.

More specifically, this study had the following terms of reference:

- Estimation of total potential catches (weight of landings) that can produce the maximum sustainable yield during 4 years of study (from 2013 until 2016). Information of potential catch will be presented, whenever possible, by stocks, fishing technique and fleet segment.
- Calculation of the difference between current landings and potential catches by stocks, fishing techniques and main fleet segments. Stocks for which MSY levels are not determined, the current landing will be used like the maximum sustainable yield.
- Estimation of economic and social indicators that can produce the maximum sustainable yield. Moreover, a comparative study between the current economic situation and the economic situation at MSY level.

To calculate the maximum sustainable yield for each specie:

First, we need to know the percentage of contribution of each fleet segment, on average four years (2013-2016). Than knowing the total MSY and the percentage of each fleet segment we can conclude the maximum sustainable yield allowed by specie for each segment.

To calculate the value of landings at MSY level:

- First we need to determine the current price of landings: *Current value of landings (€)/Current live weight of landings (Tons)*
- Value of Landings $_{\mathrm{MSY}}$ = $\mathrm{Current\ price} * \mathrm{Weight\ of\ Landings\ MSY\ (Ton)}$

4.1. Landings and value at MSY

Only 15 stocks have the maximum sustainable yield determined.

More details about landings by Specie/Fleet segment and value of landings by Specie/Fleet segment can be found on appendix 2.a.

Total landings across all stocks and segments for the trawlers, purse seiners and small-scale fleet were respectively 22,532 tonnes, 33,622 tonnes and 22,909 tonnes. Whereas, at maximum sustainable yield (MSY) the landings were estimated at 32,327 tonnes, 177,643 tonnes and 30,023 tonnes correspondingly.

Regarding the values generated, currently the three fleet generated 130 million euros, 86 million euros and 104 million euros respectively for trawler, purse seine and small-scale fleet. While, the values estimated at maximum sustainable yield were 334 million euros, 387 million euros and 197 million euros correspondingly.

As illustrated in table 6, by achieving the maximum sustainable yield, all the fleets' segments experienced an increasing in landings as well as the value.

Table 6: Comparison between current situation and the maximum sustainbale yield (Landings: Tonnes, Value: million euros)

Fishing technique		Current landings	MSY landings	Current value	MSY value
Trawler	06-12m	366	388	1.21	51
	12-18m	4,367	5,051	17	140
	18-24m	11,390	15,375	71	85
	24-40m	6,410	11,513	40	58
Purse seiners	06-12m	1,523	7,074	2	11
	12-18m	16,369	90,994	27	143
	18-24m	21,641	116,146	40	187
	24-40m	5,297	22,643	16	45
Small-scale	00-06m	281	320	1.8	2
	06-12m	7,511	8,754	26	36
	12-18m	2,772	3,954	14	72
	18-24m	12,415	17,054	62	86

Regarding the 15 stocks exploited with MSY determined, the Spanish Mediterranean fishing fleet overexploited six of them:

- Red mullet (MUT) and Common Cuttlefish (CTC): considered the most stock overexploited by all segments of trawler, small-scale and the segment 12-18m of purse seiners.
- Norway lobster (NEP): Overfished by small-scale vessels above 12m and the two segments of trawler fleet (06-12m and 18-24m). However, it is considered at the limit of overexploitation in the case of the segments 12-18m and 24-40m of trawler fleet.
- Blue and red shrimp (ARA): considered at the limit of overexploitation only on the case of the segment 12-18m of the trawler fleet. Where, its landings represent 90% the MSY.
- Anchovy (ANE): overexploited by the segment 18-24m of small-scale and considered at the limit of overexploitation on the case of artisanal vessels with medium length 12-18m.
- Surmullet (MUR): at the limit of overexploitation by the segment 12-18m of small-scale, where its landings represent 87% the MSY.

4.2. The Economic Indicators at MSY

The amount income (excluding direct income subsidies) that the trawler fleet would generate at maximum sustainable yield, on average, was estimated with 334 million euros. Total operating costs (including crews costs, energy costs, depreciation costs, other variable costs, other non-variable costs, maintenance costs, and rights costs) equated to 140.72 million euros, on average, amounting to 42% of total income at maximum sustainable yield. In terms of economic performance, the amount of Gross value added (GVA), Gross Profit (GRP) and Net Profit (NP) obtained at maximum sustainable yield was respectively: 251.70, 198.36 and 184.65 million euros.

However, the purse seine would produce an amount income (excluding direct income subsidies) estimated with 203.94 million euros, on average. Its total operating costs (including crews costs, energy costs, depreciation costs, other variable costs, other non-variable costs, maintenance costs, and rights costs) equated to 51 million euros, on average, amounting to 19% of total income at maximum sustainable yield. In terms of economic performance, the amount of Gross value added (GVA), Gross Profit (GRP) and

Net Profit (NP) obtained at maximum sustainable yield was respectively: 185.76, 153.92 and 149.69 million euros.

While, income that the small-scale fleet would generate at maximum sustainable yield, was approximated with 253.36 million euros. Amounting to 22% of total income at maximum sustainable yield, total operating costs (including crews costs, energy costs, depreciation costs, other variable costs, other non-variable costs, maintenance costs, and rights costs equated to 56 million euros. In terms of economic performance, the Gross value added (GVA), Gross Profit (GRP) and Net Profit (NP) obtained at maximum sustainable yield were respectively: 225.31, 186.28 and 181.19 million euros.

Tables contain the results of Economic and Social indicators at MSY: (see appendix 2.b)

4.2.1. Net Profit and Net Profit Margin

Over the current situation, the three fleets followed similar trend summarized in an overcapacity and negative net profit with the lowest performance showed with the trawler fleet that sustained a net operating loss. However, by achieving the maximum sustainable yield, the profitability would invert the trend. Where the three fleets experienced an improvement of the net profit generated as we can see in figure 12. Regarding the profitability of fleet segments, trawlers above18m, due to its dependence on overexploited stocks and species at high-risk, still less profitable than the rest. While, purse seiners experienced the highest profitability.

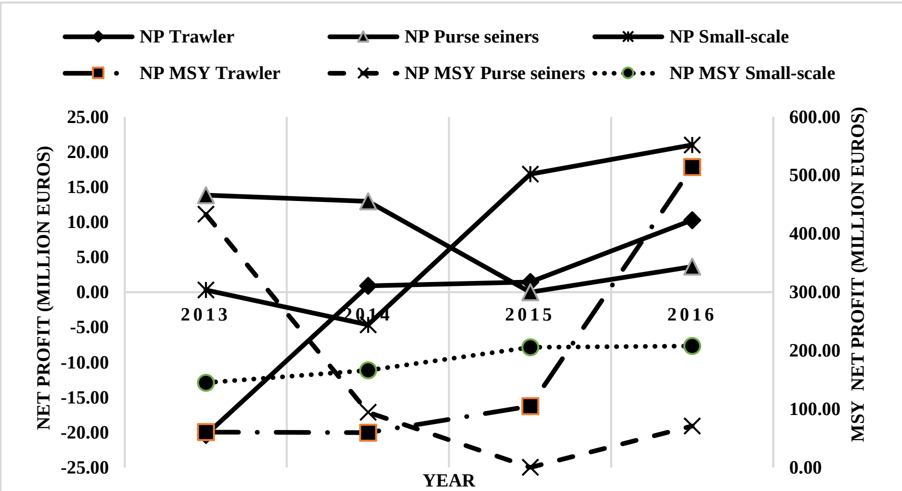


Figure 12: Comparison between the current Net Profit and the MSY for the three fleets

4.2.2. Revenue to Break-even Ratio (CR/BER)

On average, the small-scale fleet has the worst current revenue in comparison with the purse seiners and the trawler fleet, where it experienced a negative ratio in some years. Nevertheless, results obtained at maximum sustainable yield showed an important improvements of the three fleet. Where, current revenues surpassed the point of break-even. Reflecting as follows the good profitability. Especially purse seiners that experienced the highest profitability.

Referring to the fleet's segments, in the case of trawler fleet, as we said before the current situation of vessels above 18m is characterized by an overcapacity and economic unviability. However, results of maximum sustainable yield showed an improvement of those segments. Where the average CR/BER is higher than one. While, segments below 18m still generating an important cash flow.

In the case of purse seine fleet, by achieving the maximum sustainable yield, segments under 18m still more viable than the rest. Reflecting by the important revenues generated. Nevertheless, the small-scale segment 18-24m is considered more viable in comparison with the rest of small-scale segments.

4.2.3. Return on Fixed Tangible Assets (RoFTA)

Over the period 2013-2016, negative values have been recorded by the trawler and small-scale fleets operating in the Spanish Mediterranean. Classified economically unviable, the two fleets recorded an improvements since 2015.

Regarding the maximum sustainable yield, the three segments showed an improvement and an increasing trend of RoFTA. Where, the values experienced by the fleets segments were above 10%, except the segment 18-24m of trawler fleet still generating negative values.

4.3. The Social Indicators at MSY

4.3.1. Labour Productivity (GVA/FTE)

As illustrated in figure 13, the gross value added for the three segments showed an important improvement, where the highest values recorded by the purse seine fleet during the period 2013-2014. However, trawlers have the highest GVA in the last year of study. Regarding the unit produced per workers, trawler above 18m and purse seiners between 12-24m still showing an overcapacity where the values would be made by reaching the maximum sustainable yield still below the national average. Where, the value of GVA/FTE would be generate by the segment 18-24m and 24-40m of trawlers and the segments 12-18m and 18-24m of purse seiners were estimated respectively 36, 46, 48 and 42 thousand euros per full time worker.

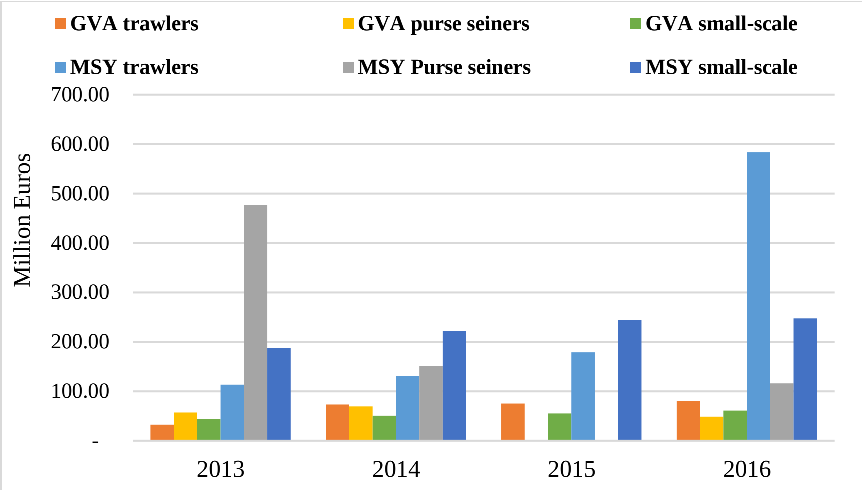


Figure 13: Comparison between the current GVA and the MSY for the three fleets

4.3.2. GVA/Vessel

The unit produced per vessel trends across the three fleets showed a similar pattern of the unit produced per worker. Summarized in an improvements and increasing of the gross value added that would be generated by vessel.

Across all years and segments, the gross value added would be generated by the three fleets was higher than the current national average that equals to 102 thousand euros per vessel. However, in the case of small-scale fleet, the segment 06-12m experienced values below the national average in both cases.

Regarding to unit produced per vessel, the trawlers and purse seiners segments below 18m still more productive than the big ones. While, in the case of small-scale, the segment 18-24m is considered the segment most productive of the fleet.

5. Modelling of profitability

5.1. Methodology

Based on the previous results of economic and social indicators' analyses, this part aimed to find the best model for three economic indicators (Net Profit, Wages and Salaries of Crew, Gross Value Added) using as explanatory variables the fuel costs and the average landings prices as well as the fishing techniques which are easily and broadly available.

This part of the study was not intended to estimate short or long-run economic and social profits functions but rather to investigate how much the fishing strategy described by the gears used and the vessel technical features (fuel costs, length, landings prices) influenced fishing profits, and which economic indicator the variables could actually explain.

A number of explanatory variables were created. Data for fuel costs, Net profit, Crew payments and gross added value were obtained from the previous section "analysis of Economic and Social indicators". However, Landings prices were obtained as the division of the value of landings obtained and live quantity landed by fleet segment.

Following the methodology of Sabatella et al. (2017), Generalized Linear Models "GLM" were formulated. A random effect model using the Generalized Linear Model estimator was applied to estimate the effects of input and output prices, as well as the fishing technique on the economic indicators. The modelling was carried out on an annual level; annual data 2008-2017 have been organized by Technique, Fleet segments, Net Profit, Wages, Gross Value Added, Fuel Costs and average landing prices.

For each economic variable, the full model was formulated based on a priori hypotheses on influential vessel and fishing activity variables derived from the previous results. All the variables were logarithmized to be close to the normal distribution. The Gaussian linear model had been used with link identity and an error obeying to the normal distribution.

Assuming as independent variables the average price of landing and the average cost of the fuel. In the loglinear equation, the coefficient are elasticities. β_x measure the percentage change in the response variable associated with a one percent change in each explanatory variable (Sabatella et al., 2017).

In similar studies, year and fleet segments were systematically included as explanatories variables. Here it is not the case because the data matrix is relatively small (about 10 years with three fishing techniques. For each techniques 4 fleet segments).

- **<u>Model selection strategy</u>**

We started with a model including all explanatory variables with a general expression;

$$\mathbf{Log\ Y_t = \beta_1\ log\ (Price\ of\ Landings)_t + \beta_2\ log\ (Fuel\ Costs)_t + Fishing\ Technique + \mu}$$

Where:

Y= the response variable (Net profit, wages of crew or Gross value added)

μ= is the error obeys to the normal distribution of N(0, σ2) and t is the year.

The relative importance of each variable was assessed by a retro-selection procedure. We used the commands "glm", "summary" and "anova" of the R statistical computing software (R Development Core Team, 2019) in order to set up and select models and carry out analyses.

A comparison strategy for models is to compare models that are not nested. Deviance, expressing the quality of adjustment, summed to a term reflecting the complexity of the model, forms the Akaike Information Criterion (AIC) that helps in the decision of the most parsimonious model (Lancelot and Lesnoff, 2005).

$$\mathbf{AIC = -2 \times \log (L) + 2\times k}$$

Where L is the maximized likelihood, k the number of parameters in the model. The deviation of the model (-2 log(L)) is then penalized by twice the number of parameters. The Akaike criterion represents a compromise between skews, which decreases with the number of parameters, and the parsimony, which reflects the need to describe the data with the smallest number of parameters possible; the best model were fitted with a stepwise selection procedure by exact Akaike Information Criterion (AIC; Akaike, 1974), and factors that were not significant were eliminated from the model. We compared the goodness-of fit of different models in relation to their complexity using AIC, which incorporates fit quality while penalizing for complexity (Burnhan & Anderson 2002). The final model will be selected with the lowest value of the criterion according to the AIC.

5.2. Results

5.2.1. Exploratory analysis

For each economic variable (NP, GVA and wages of crew) four different estimates its indirect function were produced to statistically assess the impact on profitability of input costs (namely fuel cost), average landing prices and the fishing technique:

Model I: Fuel Costs + Landings Prices + Technique

Model II: Fuel Costs + Technique

Model III: Fuel Costs + Landings

Model IV: Fuel Costs

- **Net Profit (NP)**

The decreasing trend of NP was likely effect only of fuel costs. The results, despite the limited number of observations, highlighted that the variable related to landing prices and the fishing technique are not significant, meaning that trend in real landing prices and the category of fishing gear did not explain the trend in NP, while the fuel price is always significant (see table 7). The results of models confirm that the fuel cost is significant with a probability lower than 0.01. Thus in the output of the four models the logarithm of fuel cost reporting a p(value) around 0.0005. These results seem to confirm that profitability only is influenced by the fluctuation of fuel prices.

Table 7: Results of ANOVA of the indirect NP functions

Variable	I	II	III	IV
Landings Prices	0.8888444		0.8899799	
Technique	0.1933124	0.206198		
Fuel Costs	0.0005539 ***	0.000508 ***	0.0006136 ***	0.000556 ***
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**				

- **Wages and Salaries of Crew**

In general, trends in wages of crewmembers were higher after the year 2014. Slightly increasing trends of salaries was observed for the trawler fleet and purse seiners, while an important decreasing still observed for the artisanal vessels. Contrast to the indirect function of NP, wages and salaries of crew were explained by landing prices, fuel costs and the fishing techniques. Regarding to the economic analysis, the absolute value of annual crew payment varied strongly within and between the three gears with a strong difference between the fleet segments and with the highest level for the big purse seiners.

As illustrated in the table 8, for the four fitted models, Crew payment was strongly explained by fuel costs and fishing technique, that are very significant. Thus the models assuming zero, report a p (value) lower than 0.001. Part of the within wages variability was certainly explained by the variation of the landing prices during the study period. A slight positive effect was observed between the crew salaries and the variable related to the landing prices. That is significant with a probability lower than 10%, where the output of the general model reports a p (value) lower than 0.1. Nevertheless, the output of the third fitted model, only the variable related to fuel costs is significant, whereas the landings prices is not significant, meaning trend in landings prices did not explain the variability of crew wages if it only related to fuel costs. For the explanatory variables, significant effect was observed.

Table 8 : Results of ANOVA of the indirect crew payments functions

Variables	I	II	III	IV
Landing prices	0.0531 .		0.108	
Technique	1.837e-10 ***	7.894e-10 ***		
Fuel cost	< 2.2e-16 ***	< 2.2e-16 ***	<2e-16 ***	< 2.2e-16 ***
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**				

- **<u>Gross Value Added (GVA)</u>**

Following the same pattern across fuel costs as the crew payment and the net profit. The trend of Gross Value Added was likely effect of combination of various factors. Regarding the output of models had been developed; no clear relationship appeared between the trend in landing prices and the GVA. Results of ANOVA in table 9 showed that the variable landing prices is not significant, reporting a p(value) higher than 0.1. However, trend in GVA is strongly depended in trend of fuel costs and the fishing technique. Results of models confirm that fishing techniques and fuel costs are highly significant with a probability lower than 10%. In the third output of the model, the log of fuel costs and fishing technique, reporting a p(value) lower than 0.0001

Table 9 : Results of ANOVA of the indirect GVA functions

Variables	**I**	**II**	**III**	**IV**
Landings prices	0.1697		0.2418	
Technique	3.38e-09 ***	1.375e-08 ***		
Fuel costs	< 2.2e-16 ***	< 2.2e-16 ***	<2e-16 ***	< 2.2e-16 ***

5.2.2. Economic Models

All final models selected by AIC explained a large part of the observed variability with the percent explained deviance ranging from 21% for net profit model to 80% for crew wages model. As summarized in table 10 and table 11, net profit was explained only by fuel costs. The landing prices and the fishing techniques did not significantly influence net profit. The final model explained around 17% of the deviance and with an AIC equals to 260.2. However, wages and salaries of crew were explained by landing prices, fuel costs and fishing technique. The model fitted rather well (80% of deviance explained).

The model for gross added value suggested that the main factors were fuel costs and fishing technique, in addition to landing prices. This model explained 76% of deviance and with an AIC 244.1 However, the results of anova showed that the variable landing prices is not significant while the model fitted without this variable had an AIC higher (245.98), explained 75% of deviance.

In summary, significant fuel effects were found for net profit, crew payments and gross value added. The fuel costs effect showed a reversed relationship, that increased from 2008 to 2014 and decreased thereafter. While the three indicators used to increase from 2014.

According to Flaaten (2010), a fish harvesting firm or a fisher uses several inputs, or factors, to catch fish and to land it round, gutted or processed. Inputs used include fuel, bait, gear and labour. Fuel costs have the reputation to be a major operational cost of fishing vessels, especially for large vessels using active gears like trawls, where fuel costs is often the major cost. Representing more than 30% of total trawler costs. It is not surprising that all economic indicators have been found to be influenced by fuel costs. Fuel consumption and costs are also expected to vary with the fuel price, given that the increasing trend of fuel prices worldwide during the last fifteen years has strongly affected fisheries performances (Fabienne et al., 2013).

Table 10: Summary of selected generalized linear models (GLMs) fitted to the Net Profit (NP), Gross Value Added (GVA) and Wages of crewmembers

Where the explanatory variables are fuel costs, landing prices and fishing technique

Selected Models	Variables	Estimate	Std. Error	t value	Pr(>|t|)	AIC
log(NP) ~ log(fuel)	Intercept	-0.2147	0.1927	-1.114	0.269235	260.2
	log(fuel)	0.4281	0.1180	3.629	0.000556 ***	
log(Crew_payment) ~ log(Fuel_cost) + log(Landing_prices) + Tech	Intercept	0.09956	0.22716	0.438	0.662	234.56
	log(Fuel_cost)	0.79428	0.03756	21.146	<2e-16 ***	
	log(Landing_prices)	0.29057	0.11881	2.446	0.016 *	
	TechPS	1.42115	0.19985	7.111	1.08e-10 ***	
	TechSmall-scale	0.69934	0.15496	4.513	1.56e-05 ***	
log(GVA)~log(Fuel_cost)+log(Landing_prices)+Tech	Intercept	0.69256	0.23246	2.979	0.00353 **	244.1
	log(Fuel_cost)	0.71162	0.03816	18.650	< 2e-16 ***	
	log(Landing_prices)	0.26030	0.12192	2.135	0.03489 *	
	TechPS	1.29466	0.20471	6.324	5.03e-09 ***	
	TechSmall-cale	0.74621	0.15923	4.686	7.69e-06 ***	

Table 11: Analysis of deviance table for the selected generalized linear models (GLMs) fitted to wages, NP and GVA.

Df.: degrees of freedom; Resid. Df.: residual of degree of freedom; Resid. Dev.: residual deviance

Model	Variables	Df	Deviance	Resid. Df	Resid. Dev	F	Pr(>F)
Log(Crew_payment) ~ log(Fuel_cost) + log(Landing_price)+ Technique	NULL			118	228.169		
	Log(Fuel_cost)	1	159.648	117	68.520	402.4976	<2.2e-16 ***
	Log(Landing_prices)	1	1.515	116	67.005	3.8199	0.0531 .
	Technique	2	21.788	114	45.217	27.4654	1.837e-10 ***
log(GVA)~log(Fuel_cost)+ log(Landing_prices) + Technique	NULL			119	197.823		
	log(Fuel_cost)	1	129.225	118	68.597	307.7281	< 2.2e-16 ***
	log(Landing_prices)	1	0.802	117	67.795	1.9096	0.1697
	Technique	2	19.503	115	48.292	23.2217	3.38e-09 ***
Log(NP)~log(Fuel_cost)	NULL			67	199.68		
	log(Fuel_cost)	1	33.213	66	166.46	13.168	0.000556 ***

Fuel costs represent the most important operational costs. As showed in figure 14, the average fuel price in 2016 was lower than in 2015. The decreasing trend of the fuel price had a direct impact on energy costs, further improving profitability in some typical fuel intensive fleet segments as trawlers (STECF, 2018).

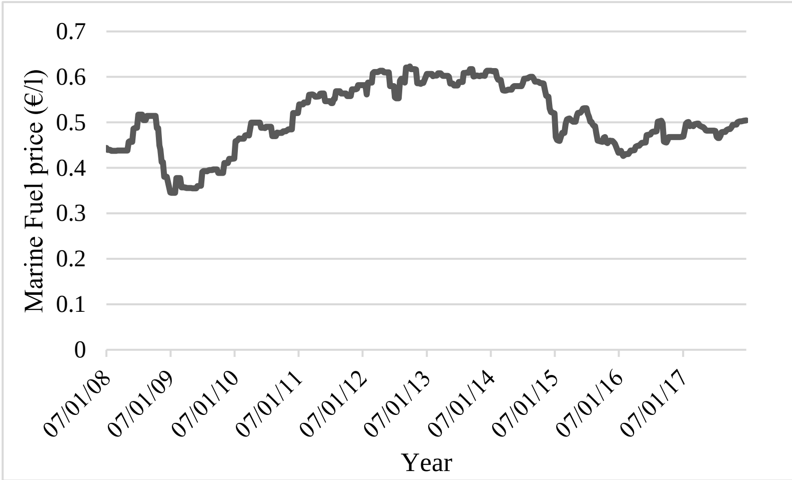


Figure 14: Spanish average marine fuel prices during 2008-2017

The recovery in the level of income, related to a reduction of operational costs, has permitted increases in net profit (see figure 15) and gross value added, in addition to wages and salaries of crew. The net profit model demonstrated the key role of fuel costs. Input fuel prices in the model were significant and positive, while average landing prices were not explaining the trend in NP. Fuel costs are major cost item especially for the trawler fleet as we said before and fuel prices were at lowest level for decade in 2016 that had a positive impact on profitability. The good fit of the Net profit model suggests that no other factors seem important for the profitability.

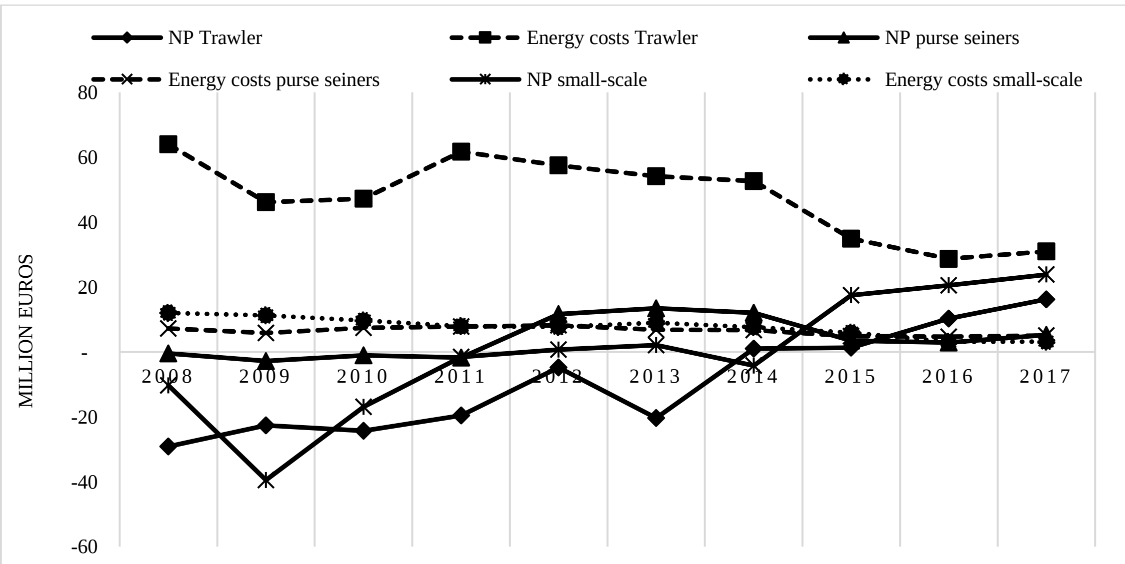


Figure 15: Trend of Energy costs and Net profit according to the fishing technique

Given that the sharing system still occurs in the fishing sector, salary costs are expected to be mostly impacted by the level of total revenue registered by the vessel representing by the variable landing prices. Where landings are considered the only resource of incomes. The full model for salary costs included fuel costs, landing prices and fishing techniques.

The Landing Prices are relatively high in the study area. This is an expected result for small-scale fisheries and trawler fleet in the Mediterranean region due to high value species, high demand for fish, and tourism that increases demand. Unal and Franquesa (2009) also stresses remarkably high average fish prices for small-scale fisheries in the Mediterranean. The average price of landings for trawler fleet, purse seiners and small-scale in 2017 was respectively €6.34 kg^{-1}, €1.89 kg^{-1} and €6.01 kg^{-1}.

Landing prices, fuel cost and fleet type played a key role in explaining net value added (GVA). Value of landings subtracting the cost of inputs, the gross value added for fishing fleets presented here varied widely. A decreasing trend of GVA was observed during the period before 2014. This finding may be mainly due to the costs per trip (fuel costs) turned out to be higher than the total revenue (the total income is practically equal to the value of the landings) per trip for some vessels/ fleet type. Mainly if there was a decrease in the fish sales price and increase in operational costs. However, after 2014 and with the decrease in operational costs, the GVA showed an important increase.

Chapter III: DISCUSSION

Economic data collection is a continuous challenge for fisheries research and management in Spain. In the beginning of 90s, first attempts were made to compile cost and earnings data of fishing fleets at the European level by W.P. Davidse [1]. This first initiative, focusing only on four European countries (France, Denmark, Netherlands and United Kingdom), was followed by a large concerted action funded by the European Commission which gathered research institutes from more than 20 countries and started to produce a yearly "Economic Assessment of European Fisheries"(Fabienne et al., 2013)

The inclusion of economic indicators in the scope of the compulsory data collection for EU member states at the beginning of the 2000s [2] was a major step for fisheries research and management. It contributed to make permanent the economic and biologic data collection through successive EU data collection regulations and provides a comprehensive overview of the latest information available on the structure and economic performance of the 23 coastal EU Member State fishing fleets (STECF, 2018). However, the economic data collection program becomes more and more difficult to implement in national sampling programs (Van Iseghem et al., 2011) because it does not cover all vessels as some years, specially the data provided for the small-scale vessels in the case of Spain, only data related to large vessels are have been collected correctly to provide economic information.

By analysing all economic indicators of the Spanish Mediterranean fleet, this study significantly increases the knowledge on profitability structures and helps to understanding the economic circumstances in the fishing sector at the area 37.

- The Economic Performance

The relationship between capacity and activity in fisheries is a complex issue in the economic scientific advisory process. Modelling the entry-exit behaviour (capacity) of the fishing plants (vessels) is not straightforward; various approaches have been tested in different studies (Da-Rocha et al., 2017)

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[1]: Davidse, W.P., 1993. Costs and earnings of fishing fleets in four EC countries. Agricultural Economics Research Institute (LEI-DLO), The Hague, p. 202 p.

[2]: COUNCIL REGULATION (EC) No 1543/2000 of 29 June 2000

As already discussed above, the fishing capacity of the Spanish Mediterranean fleet has decreased remarkably in the last years in order to bring fishing capacity in balance with fishing opportunities. The number of vessels decreased by 33%, 20% and 28% correspondingly to trawler, seiners and artisanal vessels. Gross tonnage (GT) showed a similar decrease by 36%, 12% and 30%. Whereas starting the year 2016, the economic performance shows an improvement. Where, over 2016-2017, an increasing by 0.26%, 3% and 22% respectively for the trawler, purse seine and small-scale fleets had been observed.

The decreasing in capacity was accompanied by a structural resizing of the productive structure even in terms of total landings (Sabatella et al.,, 2017) where the measure established on The European Maritime and Fisheries Fund for the Final-exit aid for scrapping of vessels in order to reduce capacity and fishing effort of the fleet, targeted at segments of fleet at overcapacity, (STECF, 2018).

Regardless of the reduction in the number of vessels and gross tonnage, in addition to the declined in fishing activity of the fleets, where number of days at sea had decreased with 5%, 2% and 12% respectively for trawler, purse seiners and small-scale vessels, according to the European Commission (2016) the results of stock assessments demonstrate that stocks are still largely overfished and/or in a bad state. Moreover, as demonstrated in the previous chapters, we showed that trawler, as artisanal fleet are especially overexploiting red mullet, European hake, shrimps and Norway lobster while purse seiners dedicated to anchovies, Atlantic mackerel.

In recent years European fisheries managers have witnessed the success of the European CFP in the north (i.e., North East Atlantic, Cardinale et al., 2012; Fernandes and Cook, 2013) and at the same time, its failure in the south (i.e., Mediterranean Sea, Colloca et al., 2013; Vasilakopoulos et al., 2014). Thus, despite the fact that both areas are managed under the same broad fishery policy (i.e., European CFP), a large discrepancy management performance still occur between the North East Atlantic and the Mediterranean Sea (Cardinale y Scarcella, 2017).

The fishing mortality exerted on the North East Atlantic has shown a rapid and general decline during the last 15 years and even the spawning stock biomass has started to show clear signs of increasing for several stocks in the North East Atlantic area (www.ices.dk). Nevertheless, Mediterranean stocks have largely declined in the last 15 years and their exploitation level has raised or remained above the F_{MSY} level during the same period of time (Vasilakopoulos et al., 2014).

Indeed, the analysis of landings by fleet segments and by species with MSY determined showed that most of the catches are taken by the trawlers and purse seines. Also, catches of small pelagic, Norway lobster, and shrimps are mainly taken by trawlers and purse seines. Only for red mullet and hake, the small-scale fisheries take a significant but still minor part of the catches. As demonstrated by Cardinale and Scarcella (2017), effort reduction is not accompanied by a concomitant reduction in fishing mortality for all species, where the ratio F/FMSY for some important target stocks of demersal fleets like red mullet and giant red shrimp has significantly declined over time, even if the value is still above one.

The analysis of economic indicators presented also the critical situation of artisanal fleets and especially trawlers operating in the study area during the period before 2014, where negative values of net profit and ROFTA have been recorded. However, during the last two years of study, all fleets showed an improvement. The costs per trip turned out to be higher than the total revenue per trip for some vessels, mainly for trawlers (Rodrigues et al., 2019). In this sense, the negative trend in the Net economic profit highlighted the inefficiency of the sectors that is not able to cover the total costs of inputs with the revenues obtained by output values (Sabatella et al., 2017).

Except the purse seine fleet that presented a respectable profitability in comparison with the rest, considering the years and the fleet segments, even the medium and long-term profitability of the fleets presented respectively in terms of CR/BER and ROFTA showed very low if not negative values, thus indicating a situation of long-term economic inefficiency and overcapitalization.

As a consequence of the economic overcapitalization, the standard living of fishers especially workers at trawler fleet showed a precarious situation due to the lowest amount of benefits gained. A comparison between the three fleets showed that only fishers in purse seiners generated a good amount of benefits. While, an increase in the wages and salaries of crew was observed in the last 3 years of the period under analysis for the trawler and purse seiners, while the small-scale fleet showed a decrease in the wages of crew over all the period of study.

Conversely, analysis of economic indicators that estimated at maximum sustainable yield showed a good profitability and a long-term efficiency. Profitability was positive for all the fleets presented by positive and good values of ROFTA.

- Explaining the fishing profitability

In this part of study, we modelled the economic performance in the study area basing on three economic indicators. It should be understood that the estimate of the net profit and gross profit can be considered as the main indicators for the availability of the fisheries in the short and/or long term. Founding the perfect explanatory variables that can influence the economic profitability of fishing sector can be the first step to understanding the current situation of the sector and can subsidize more comprehensive studies, such as studies on modelling fisheries costs; moreover, this work may also be useful to alert decision-makers to the need for more effective fisheries management.

We showed that the main factor affecting the profitability levels is the fuel costs. Input prices (and in particular fuel price) in the three models were significant, while average landing prices and fishing technique were not explaining the trend in Net Profit. Indeed, the final Net Profit model confirms the strong influence of the fuel costs. The absence of a gear effect and landing prices for Net Profit may be the consequence of no change in fishing behaviour, which would have reduced fuel consumption.

The result of analysis showed that Fuel and salary costs were the primary operational costs for all fleets. The differences in the level and structure of those costs observed between the fleets segments can be related to their dynamics of the fishing operation. For instance, in general, passive fishing methods, small-scale fleet, tend to be less energy demanding (fuel consumption) than ‘active’ ones (trawls and seiners). When comparing the smallest segments and small-scale fleet with big ones such as trawlers and purse-seiners, it is evident that small-scale segments consume less fuel, and therefore, this factor can contribute to lower operating costs. Negative returns had already been evidenced when fuel consumed per trip exceeded the total revenue per trip. Fuel cost played a key role in explaining Net Profit.

The fitted models of GVA and wages of crew demonstrated the key role of fuel costs and fishing technique in addition to average landing prices for the area 37 fleets. This fact opens an important question about the remuneration systems being based on productivity (landing and landing prices), consequently providing incentives for the captains to increase production in order to maximize their personal income as showed by Vestergaard (2010). Which confirms the key role of the total revenue ("value of landings") for crew expenses, according to the share system, which is still the most usual crew payment system in fisheries. However, labour wages can be varied if there are significant changes in the fishing conditions due to management measures, uncertain catches due to overfished fish stocks and increases in fishing effort (Guillen et al., 2017).

The gross value added for fishing fleets presented here varied widely, large artisanal fleet, and purse-seiners may be considered highly profitable. This finding may be mainly due to these fleets presenting higher revenue, with a balance between the volume of sales and the value of the product (higher fishing efficiency). For example, purse-seiners presented the lowest ex-vessel price/kg (€ 1.86) but had the highest weight of catch (430 thousand tonnes) when compared to the other fleets studied.

On the other hand, trawler fleets and small artisanal segments (under 12m) had the lowest profitability, with a negative values of gross profit and net profit margins between (-32%) and 4.5%, mainly if there was a decrease in the fish sales price and increase in operational costs as showed in previous section.

Actually, the data reported in this study, showed a trend change of the economic indicators in the last 3 years which started to increase. An increase trend biomass of Black-bellied anglerfish in GSA 01 as well as the improvement in recruitment of Sardine in GSA 06 and Black-bellied anglerfish in GSA 05 as GSA 06 (STECF, 2015) could be considered as positive drivers, which impacted positively on economic profitability of the fisheries concerned. Even the technical and fishery management provisions in the Mediterranean Sea, especially the one managed through national management plans, could be considered as drivers producing positive effects in the long term (Sabatella et al., 2017).

Paradoxically, trawlers and purse-seiners that have the important active segments in the studied area, may be targetting fully fished or overfished species as anchovy (F_{2016}/F_{MSY} = 1.192 in GSA 06), sardine and Atlantic horse mackerel. Although there are not updated stock assessments for target species such as shrimps, red mullet, hake and other demersal fishes (STECF, 2017b) and have been mentioning declining yields, and fleets overlapping the same target resource. Considering net output of the sector (GVA)/wages of crewmembers and prices of catches correlate statistically in this study, thus, it should be mentioned that unmeasured biological factors such as population size and hyper-stability (catch per unit effort remaining high as fish density declines) of target species may be also influencing the benefits of fleets that will be reflecting in negative gross value added and lowest crew payments.

Thus, the bad economic performance found for some fleets highlights the need of better knowledge on population status, market prices (landings and fuel). The highest fuel costs effect founded in the three fitted models may also be useful for future bio-economic models that had better explain the dynamics of stock abundance, cost, revenues and profitability. In particular, the differences in profitability short/long term and crew payments between the analysed fleets are possibly due to the number of trips per month, different fuel costs, and in addition, different prices fetched for the same species (e.g. hake) in different segments and gear type.

In fact, this result is consistent with the differences in the relationship of catch volume between the three Spanish Mediterranean fleets, where consequently, larger catches produce high profits but also a larger consumption of fuel costs.

On the other hand, the evidence of the effect of gear type on net output can be especially attributed to smaller segments and artisanal vessels, that cannot expand their catch and revenues because they are limited to waters close to shore, due to their low autonomy and restricted storage capacity.

Thus, how cost and total revenue can be largely attributed to effort or stock size, respectively, for the lowest profitability fleets presented here, the cost of fuel would seem greater than it could be and may indicate overfishing and fleet overcapacity. However, fisheries are capable of earning substantial profits provided they are effectively managed (Arnason et al., 2009). Indeed, the key role exerted by fleet category (type/segment) on the statistical and economic analysis confirms the importance for the implementation of a fleet management system in the study area. In addition, the establishment of specific management measures by fishing category (type/segment) could be an alternative for the three fleets that presented quite a distinct performance among the period of study. Conversely, fisheries management has many objectives, of which increasing economic performance is only one (Pascoe et al., 1996). Thus, the low economic performance of the fleets should not only encourage management measures, since high economic profits can stimulate the entry of new vessels into a fishery, thus intensifying pressure on stocks (Whitmarsh et al., 2000). To avoid fishing pressure, and consequently biological overexploitation and a less efficient fishery (both technically and economically), input controls (fishing capacity and effort controls) need to be designed in combination with output controls, directly restricting catch, as showed by Prellezo et al. (2017 and 2012). If a few input aspects are regulated, fishing fleets may act to maximize their individual well-being, using unregulated dimensions for increasing the effort, leading to excessive investment in fishing technology, which may result in unpredictable and unfavorable consequences (Rodrigues et al., 2019).

However, a striking difference in the management of marine fish stocks between North East Atlantic and the Mediterranean Sea is that Mediterranean Sea is primarily managed by effort control while North East Atlantic stocks management has been based primarily on TACs, which are regularly provided by ICES to the EC. Recent trends in decision making indicate that scientific advice in the North East Atlantic has been more closely followed in later years, with the proportion of EU TACs set above scientific advice that has declined from 33% in 2001 to only 7% in 2015 (Carpenter et al., 2016) while no such trend exists for Mediterranean stocks. Even the realized reductions in effort (e.g., a minimum reduction of bottom-trawling fishing effort in the Mediterranean is foreseen by GFCM resolution RES-GFCM/33/2009/1, GFCM, 2009) have always been much smaller than what deemed necessary by the scientific advice (Colloca et al., 2013).

For the multispecies fisheries in the Mediterranean considering that the exploitation of shared stocks implies a multiple management levels, where the management of resources is outside the responsibility of the individual states, GFCM and European Commission are undertaken several common actions to enforce a rational management and best utilization of living marine resources (Sabatella et al., 2017).

Indeed, referring to similar study of Sabatella (2017) showed that the introduction of new management measures leads to economic losses in the short terms because fisheries need time to adapt to regulation adjustments, whereas new and more effective management instruments, like Long Term Management Plans, updated National Management Plans based on MSY target and Harvest Control Rules, are needed to face the critical state of Mediterranean resources and ensure a long term economic sustainability of fisheries.

In addition, the fleet individual and/or segment results of economic and social indicators analysis presented here may be useful for helping businessmen and vessel owners to identify factors that are influencing fleet profitability, which may facilitate the creation of measures for improvements in the internal processes of the fishing activity.

Indeed, changes in technological and operational measures, in addition to behavioral adaptations, can result in significant improvements in profitability as a result of reduced costs. For example, fuel savings can be achieved by transition to pulse fisheries using pulse technique. As showed by Turenhout (2016) the transition from beam trawl fisheries to the cost-effective fisheries with pulse technique has made a significant contribution to the profitability of Dutch cutter fisheries. The switch from beam trawl fisheries to pulse fisheries has led to a change in effort distribution in the areas where fishing takes place. The reason for this is that fishing grounds that were previously avoided are now accessible. Also, it has considerably reduced the fuel consumption (approximately 46% lower than in beam trawling) and CO2 emissions of the cutter sector. Fishing with Pulse technique is particularly efficient where the increase in profitability (higher catch proceeds and fuel savings) has also led to an increase in catch-based pay for the crew.

Finally, the results presented could also be useful to guide the government agencies that dictate the development and modernization of Spanish fisheries in the adoption of credit liberalization policies that prioritize the low-profit vessels in the acquisition of low-impact and cost-effective technology improvements (e.g., incentives for the purchase of engines that consume less fuel). In addition, the results warn for a possible risk in the release of the incentives for the acquisition of new vessels for the fleets that are close to the negative gross profit. Where the government support for vessel construction should inevitably lead to the overcapitalization of the fisheries, with adverse consequences for stocks, profitability and fisher salaries (Rodrigues et al., 2019)

Conclusions

This work has been carried out in the context of the European project PANDORA and aimed to analysis of economic performance and fishing profitability.

For the fleets as a whole, the financial returns were positive over the last 2-3 years of reporting period, indicating an improvement in the fleets' profitability. Nonetheless, with exception of big purse seiners, all fleets across the period before 2014/2015 were less profitable and close to a negative gross profit (negative values of NP, ROFTA and CR/BER had been recorded), especially because there was an increase in fuel costs, which played a key role in explaining the fleet profitability and were identified as the main operating costs.

The results also highlighted the critical economic status and the inefficiency of the sectors that is not able to cover the total costs of inputs. Indicating a situation of long-term economic inefficiency and overcapitalization.

Purse-seiners were the most profitable fleets. Thus, gross profitability varied significantly among the fleets (type and segment) and was clearly related to the following main factors: fuel costs, fish price, and for technical features for certain fleets, (trawlers and purse seiners are more efficient than the artisanal vessels).

Labour costs (or labour wages) are influenced by catch prices (value and volume) as well as the running costs of fishing (or fuel costs) in addition to the gear type, whereas wages are constrained by reduced productivity and high operational cost levels.

The findings should guide decisions and resolutions aimed to redress the economic situation of vulnerable fleets and in fishery alternatives management measures as a TAC based system and/or recovery plans for overfished stocks, especially for the trawlers, purse-seiners and the big small-scale segments whose commercial fishing is operating in a scenario of overcapacity and overfished stocks. To ensure the profitability of regional fisheries, the introduction of a management system that aims at reducing overcapacity while promoting the recovery of overfished stocks seems urgent. Thus, putative management based mainly on reduction in nominal effort has failed in the Mediterranean Sea and it is most likely that it will most likely fail also in the near future (Cardinale et al., 2017).

The findings indicate considerable variation in economic performance within and between the fleets. As such, they can be a benchmark and can highlight the need of future surveys, better knowledge on population status and market prices, may provide support to decisions by vessels owners, and can be used as a basis for management discussions. In this sense, the variation in the performance of the fleets according to vessels length is an important factor for management purposes since fleets may not be treated homogeneously but only in terms of fleet type and segment.

Finally, while it is noted that economic data on Spanish fisheries (region/gear type and fleet segment) are scarce and with the difficulty to update annually the fishing data base, which generally requires voluntary involvement of fishing enterprises, this study presents a method and an approach for economic data analysis that may contribute to standardizing economic knowledge construction in data-poor fisheries and offer interesting alternative for fisheries analyses by ranging from the assessment of the economic status of fisheries to bioeconomic modelling.

However, it has to be noticed that the interpretation of economic indicators with only the three variables is not sufficiently robust from a statistical view because available time series are still too short and the aggregation of variable fleet segment and years as explanatory variables is recommended. Thus, the result of analysis of economic indicators showed the existence of variability of economic performance according the fleet segment and the year of study.

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Appendices

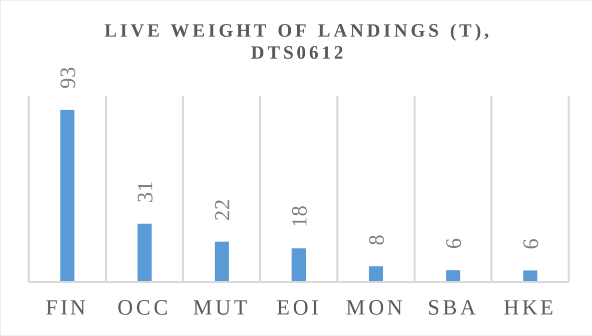
Appendix1: Current Situation

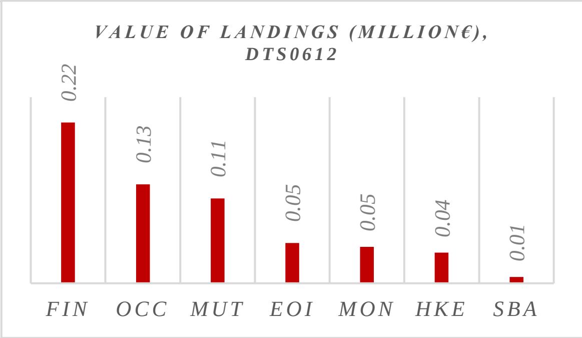
a. Variable to calculate CR/BER

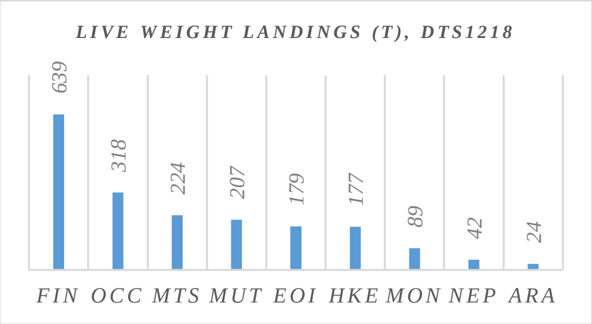
Current income (not including subsidies)	Fixed costs	Variable costs
▪ Income by fishing activity ▪ Other revenue from the exploitation of the vessel, such as tourism, recreational fishing, etc.	▪ Annual depreciation or amortization ▪ Non-variable costs consist of: - rental of machinery or equipment - Insurance premiums - Repair and maintenance of tangible fixed assets on land - Water, gas, electricity (land) - Commissions (land) - Transport and freight (land) - Office supplies (land) - Communications (land) - Legal and accounting advice, computers, advertising (land) - Cofradias and/or associations fees - Travel and daily subsistence allowance for ground staff - Other land expenses - Other taxes on production - Total cost of land wage-earning personnel	▪ Crew wages and salaries ▪ Unpaid work (imputed value of unpaid work) ▪ Costs of spare parts, repair and maintenance of the vessel ▪ Energy costs (fuel) ▪ Other variable costs include: - Bait, salt, ice, containers and packaging - Procurements - Fishing gear - Lubricants - Communications - Transport and Freight - Travel and subsistence - Port charges - Port fees - Cofradias or associations fees - Licensing Other ship's expenses

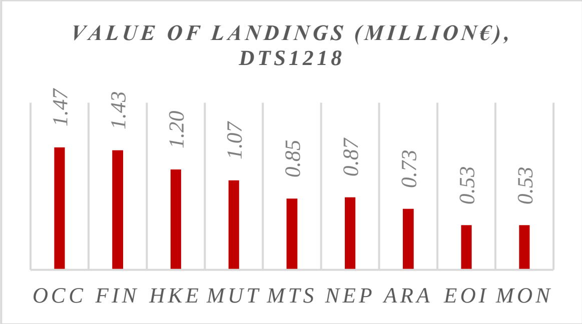
b. *Landings and Incomes of landings*

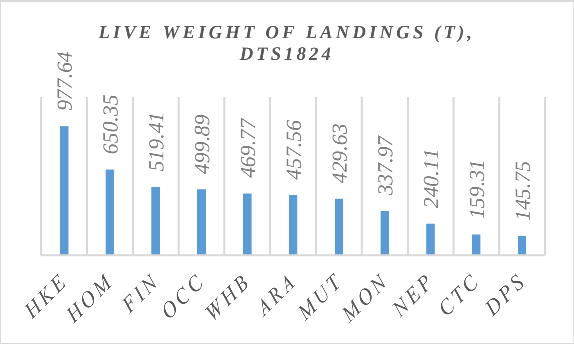
DTS

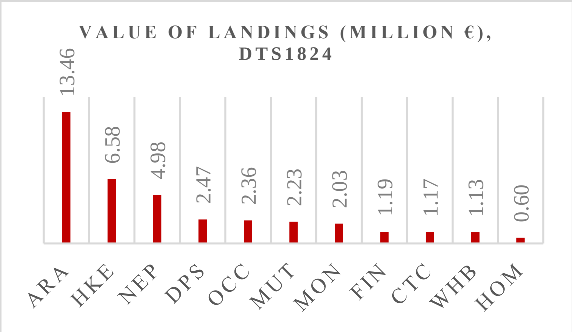


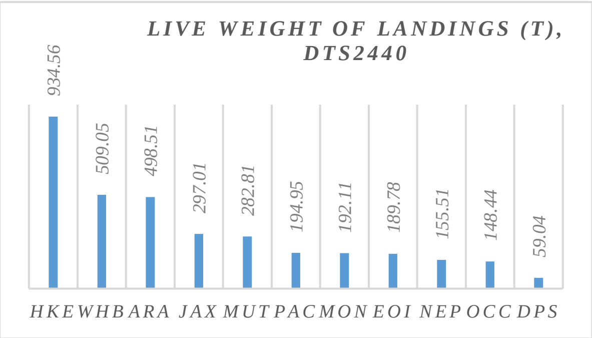


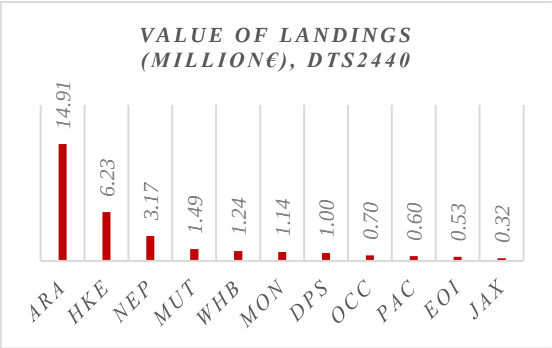




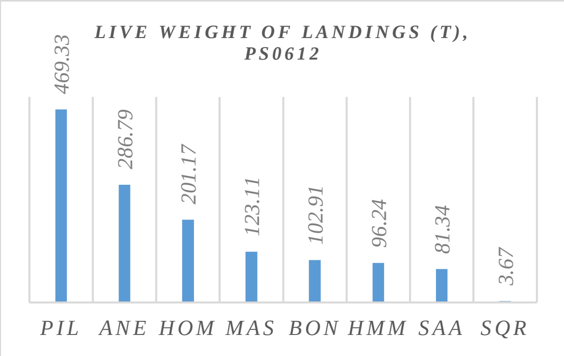


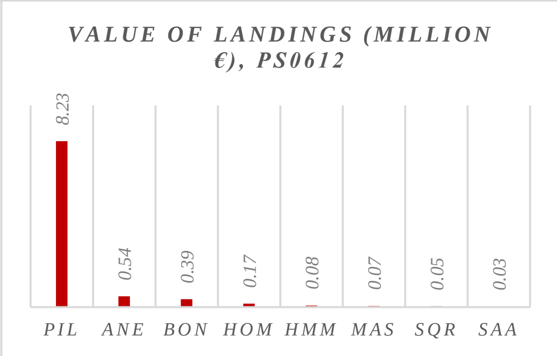


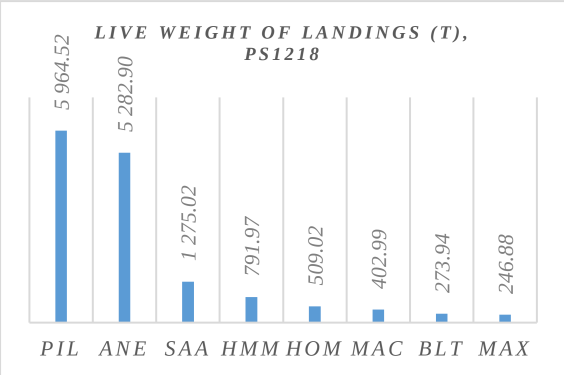


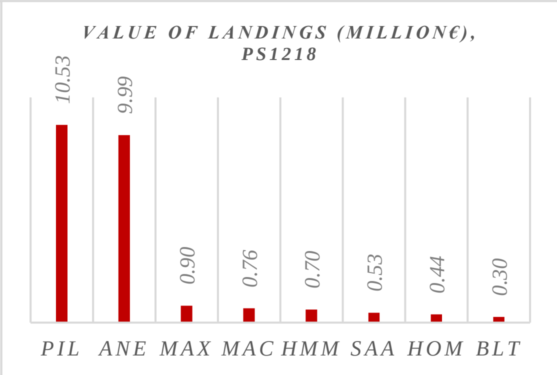


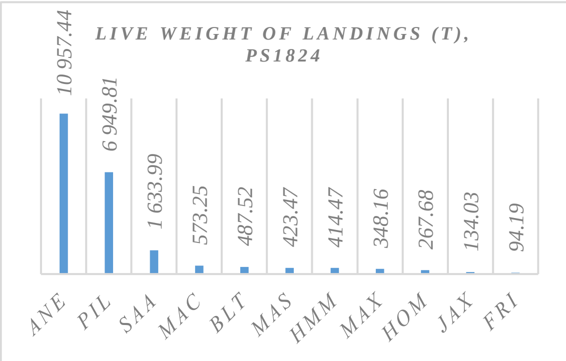
Purse seiners (PS)

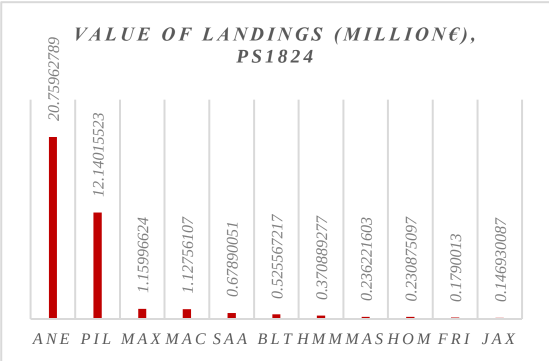


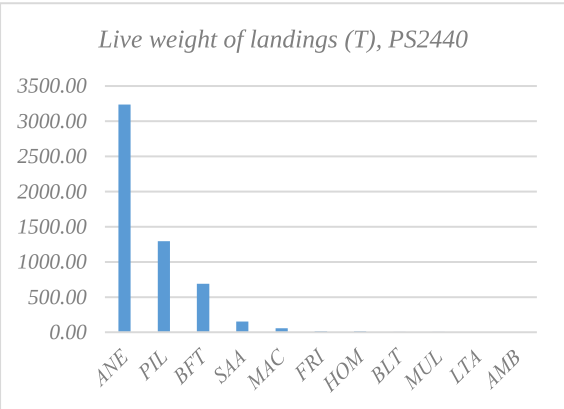


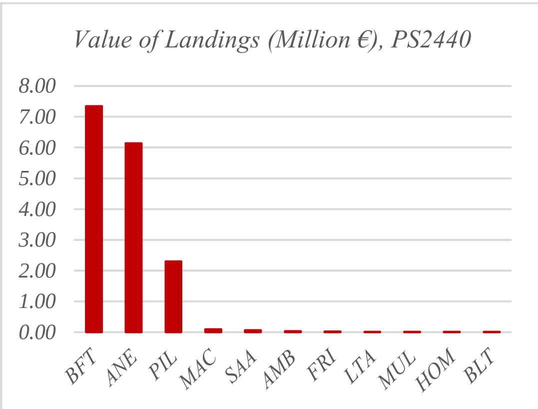




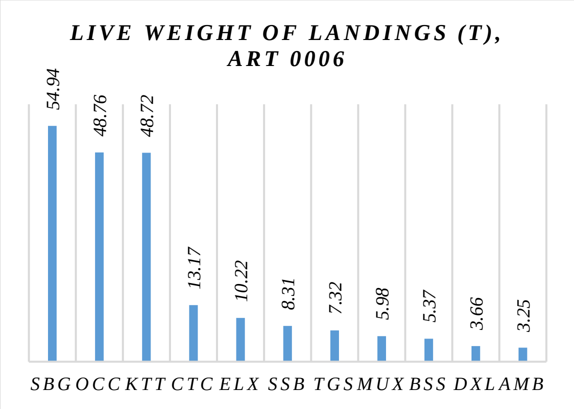


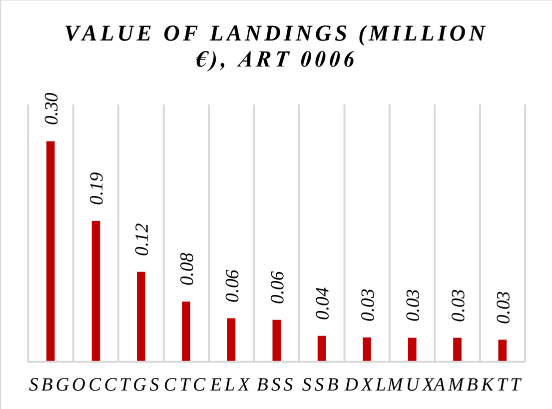


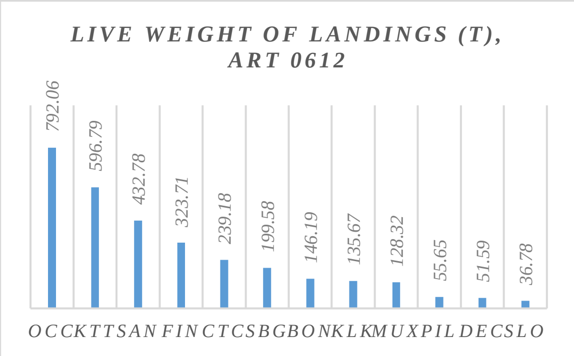


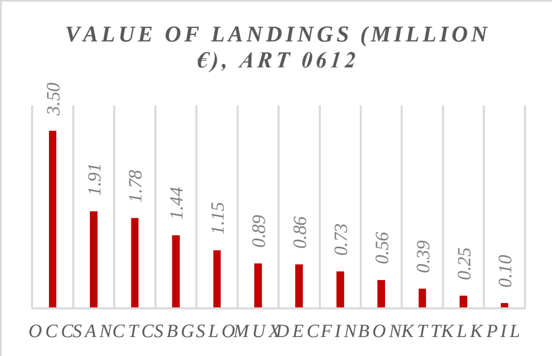


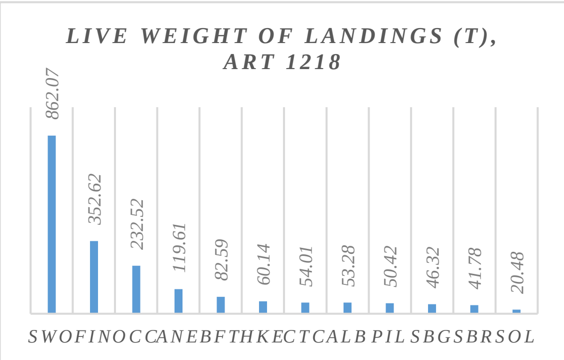
Small-scale fleet

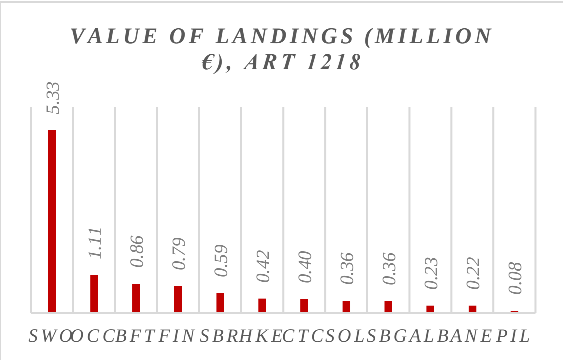


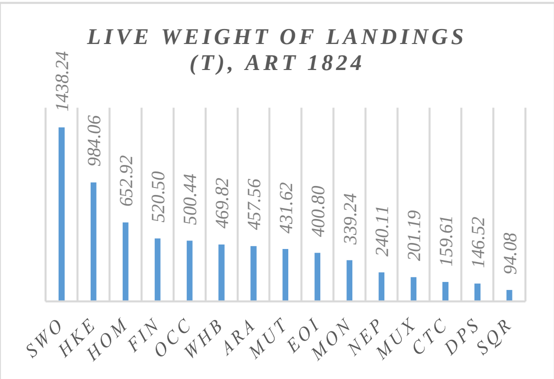


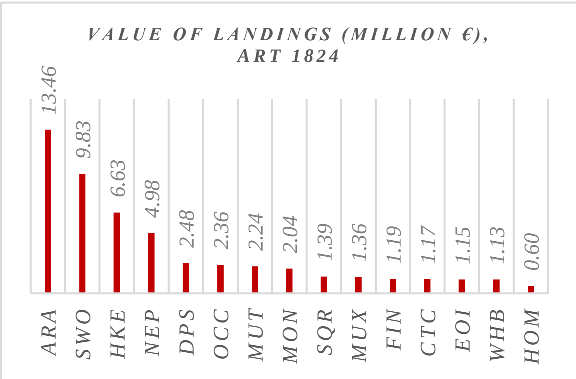












a. *Economic & Social Indicators*

- *Net Profit (euro)*

fs_name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
DTS0612	-237487.37	-40685.21	133844.07	131826.40	477570.93	-131311.28	-392888.56	-10158.20	242174.67	278610.56
DTS1218	-1048594.39	139188.52	-4200173.53	-5810456.19	1277132.77	-925343.44	686681.09	729559.96	-998927.48	45221.95
DTS1824	-20187917.69	-11498660.43	-9046875.16	-1884335.96	-1381320.90	-9993930.05	2197874.88	1847195.61	3839401.70	6747907.76
DTS2440	-7657179.04	-11242633.47	-11165759.11	-12045680.85	-5132376.93	-9322666.33	-1458034.61	-1227936.03	7195227.12	9157714.70
PS0612	223685.53	158990.61	1257767.35	338268.44	813112.22	694880.91	1272272.72	66474.47	157342.04	184897.67
PS1218	244310.74	2582275.64	488202.16	1027232.54	-643879.28	2909601.86	3300472.04	396375.34	-111235.94	341163.62
PS1824	-927115.44	-2206441.26	-1749541.85	-3601459.28	3297282.95	8150718.22	7494508.10	654730.82	826518.34	1951840.50
PS2440	13819.97	-3330380.62	-1055794.53	457612.70	8198205.87	1701720.19	8648.84	2377378.09	2037887.67	2787237.28
Art 0006	-197037.68	-21182683.94	-10578483.73	-34052.99	-305443.00	-1443371.56	448843.19	147969.96	179670.91	223003.56
Art 0612	-6911350.31	2547488.32	5320329.05	-307685.91	-1666976.84	1310384.93	-3855465.72	15996275.11	10885499.29	12676659.59
Art 1218	-2921037.47	-19781263.54	-11233968.60	-1360243.29	2680713.80	-284172.85	-1146618.27	863347.16	8684345.98	10392882.01
Art 1824	-314677.08	-1066065.22	-446313.50	134668.39	7929.41	2473777.67	319708.56	472756.66	754273.10	536571.51

- *CR/BER period 2008-2017*

TECH	Segment	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
DTS	06-12	0.29	0.86	1.66	1.67	3.11	0.20	-1.26	0.96	6.96	13.03
	12-18	0.70	1.03	0.00	-0.49	1.39	0.76	1.22	1.23	0.68	1.02
	18-24	0.02	0.56	0.42	0.87	0.92	0.40	1.19	1.15	1.36	1.66
	24-40	0.43	0.27	0.10	-0.16	0.26	-0.45	0.80	0.85	2.84	3.59
PS	06-12	2.60	1.49	12.00	5.17	5.11	9.62	17.99	1.61	2.40	2.95
	12-18	1.14	1.96	1.25	1.64	0.51	2.62	2.88	1.21	0.95	1.15
	18-24	0.74	0.61	0.72	0.32	1.61	6.12	2.92	1.19	1.19	1.45
	24-40	1.00	0.19	0.64	1.15	2.86	1.42	1.00	1.71	1.72	1.99
Small-scale	00-06	-11.48	-10.20	-10.11	0.53	-1.18	-18.13	5.92	1.40	3.04	4.04
	06-12	-1.22	1.38	1.94	0.92	0.56	1.23	0.27	4.65	3.52	4.19
	12-18	0.49	0.20	-2.28	0.40	3.67	0.89	0.78	1.32	6.48	8.21
	18-24	0.65	0.29	0.58	1.17	1.01	3.33	1.35	1.37	2.44	2.34

- ***Average wage per FTE (Million of euros)***

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SMI	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
SMA	**0.02**	**0.02**	**0.02**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**
DTS06112	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02
DTS1218	0.01	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02
DTS1824	0.02	0.02	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.02
DTS2440	0.02	0.03	0.04	0.02	0.02	0.02	0.02	0.02	0.03	0.03
PS0612	0.00	0.02	0.04	0.02	0.01	0.02	0.02	0.01	0.01	0.05
PS1218	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.05	0.02	0.02
PS1824	0.02	0.02	0.01	0.02	0.01	0.02	0.03	0.02	0.02	0.02
PS2440	0.07	0.04	0.03	0.03	0.03	0.07	0.05	0.04	0.05	0.05
Art0006	0.01	0.23	0.18	0.01	0.03	0.04	0.03	0.02	0.08	0.02
Art0612	0.01	0.02	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01
Art1218	0.01	0.04	0.04	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Art1824	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02

- *GVA/FTE: Period 2008-2017 (Unit: Thousand Euro)*

TECH	fs_name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
DTS	06-12	16.46	37.90	24.59	26.84	29.65	28.11	15.87	21.40	35.41	38.80
	12-18	17.35	33.27	20.51	15.32	38.05	21.43	20.64	30.77	26.21	30.17
	18-24	15.97	28.89	18.21	25.95	20.74	19.62	26.80	28.25	32.12	35.64
	24-40	25.28	31.48	38.76	18.42	30.14	11.27	30.93	31.27	44.62	49.06
PS	06-12	7.66	23.53	85.70	23.88	22.06	26.79	61.57	11.65	16.06	17.52
	12-18	11.68	20.23	23.16	16.91	17.33	30.29	32.23	24.58	21.20	23.18
	18-24	19.92	27.43	13.90	21.39	23.66	34.86	40.02	23.03	21.82	24.01
	24-40	93.28	41.88	33.74	45.96	84.93	105.72	65.59	63.92	73.63	80.49
Small-scale	00-06	6.57	58.56	48.39	8.76	25.82	13.93	40.48	27.79	22.31	24.10
	06-12	22.90	52.45	41.79	123.52	95.18	82.80	100.95	116.13	104.92	114.91
	12-18	32.44	12.05	30.46	30.74	83.07	60.22	67.29	77.90	132.12	145.10
	18-24	14.60	18.28	27.91	32.80	18.87	40.97	23.80	24.11	30.00	30.37

- If GVA/FTE segment < GVA/FTE fishing sector = Red
- If GVA/FTE fishing sector ≤GVA/FTE segment≤ National GVA/FTE = Yellow
- If GVA/FTE segment ≥ National GVA/FTE = Green

Varb_Name	unit	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017
GVA ESP	million	1 025 645.00	1006093	989 883.00	980 367.00	980 992.00	1 014 839.00	944470	980992	1014839	1057467
FTE ESP	thousand	19 849.80	18642.1	18148.1	17647.2	16797.2	16255.8	16393.5	16937.5	17453.8	17951.3
GVA/FTE	thousand	51.67	53.97	54.54	55.55	58.40	62.43	57.61	57.92	58.14	58.91
GVA fishing	million	585.80	884.40	849.90	910.70	883.20	879.00	1059.60	970.40	1087.80	1 101.10
FTE fishing	number	31 921	35 844	33 678	33 210	30 302	28 782	28 629	30 015	29 399	29 206
GVA/FTE	thousand	18.35	24.67	25.24	27.42	29.15	30.54	37.01	32.33	37.00	37.70

- ***Gross Value Added per Vessel (GVA/VESSEL) : unit Thousands of Euros***

TECH	fs_name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
DTS	06-12	32.64	60.45	41.60	44.69	65.08	46.75	24.83	61.64	38.52	42.21
	12-18	48.50	90.91	58.02	45.04	69.51	68.10	85.09	84.38	68.34	78.67
	18-24	66.33	112.56	74.54	93.75	96.24	46.01	113.47	123.11	135.82	150.67
	24-40	137.66	168.87	170.32	71.10	110.31	36.10	151.52	174.02	219.04	240.84
PS	06-12	16.32	52.95	89.34	87.99	95.09	105.54	93.09	37.51	64.29	70.14
	12-18	72.08	155.83	138.84	133.83	82.56	203.59	229.81	168.97	159.75	174.64
	18-24	191.00	230.52	165.65	73.16	204.24	256.94	395.85	233.51	235.31	259.01
	24-40	606.24	301.20	302.72	403.49	738.11	523.78	417.21	466.05	518.83	567.15
Small-scale	00-06	1.87	24.32	12.52	1.89	13.28	5.22	23.05	17.41	12.40	13.40
	06-12	12.93	27.09	28.35	32.16	20.62	26.67	29.94	35.08	10.50	10.50
	12-18	63.09	18.10	45.20	21.76	40.56	35.72	46.49	54.32	89.33	98.10
	18-24	107.85	107.56	103.04	144.67	159.28	255.32	172.33	248.80	158.39	160.36

The National GVA/VESSEL

Varb_Name	unit	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017
GVA fishing sector	million	585.80	884.40	849.90	910.70	883.20	879.00	1059.60	970.40	1087.80	1 101.10
NB Vessels	number	13115	11501	11209	10900	10544	10167	9921	9686	9459	9 356
GVA/Vessel	thousand	44.67	76.90	75.82	83.55	83.76	86.46	106.80	100.19	115.00	117.69

Appendix2: The maximum sustainable yield

a. ***Species overexploited and value genertaed (euro)***

Sp code	*Fs name*	*Catch$_{2016}$/MSY*	*Current value*	*MSY value*
MUT	***DTS0612***	2.83	131 410	46504.05
	DTS1218	3.47	1 538 144	443727.73
	DST1824	3.46	3 174 057	917391.68
	DTS2440	2.66	1 618 274	608877.93
	PS1218	3.30	656	198.75254
	Art0612	2.61	11 808	4530.9972
	Art1218	3.57	391 194	109674.23
	Art1824	3.46	3 211 277	928149.34
NEP	***DTS0612***	1.27	44 912	35407.289
	DTS1218	0.95	851 696	900465.06
	DST1824	1.07	5 441 573	5088965.8
	DTS2440	0.97	3 179 964	3280438.4
	Art1218	1.26	955	756.45847
	Art1824	1.07	5 441 748	5089129.7
ARA	***DTS1218***	0.90	940 732	1043303.1
CTC	***DTS0612***	1.92	38 564	20071.984
	DTS1218	2.29	725 779	316985.48
	DST1824	2.16	1 505 574	698336.45
	DTS2440	2.04	413 445	202518.51
	PS1218	1.73	2 259	1309.4462
	Art0006	1.27	71 911	56695.023
	Art0612	2.16	2 263 312	1050025.9
	Art1218	2.46	583 192	236824.94
	Art1824	2.16	1 514 774	702603.34
ANE	***Art1218***	0.91	444 361	487048.27
	Art1824	1.48	712 292	482782.06
MUR	***Art1218***	0.87	175 391	201661.6

b. *Indicators at Maximum sustainable yield*

- ***Net Profit margin***

fs_name	Var	2013	2014	2015	2016
DTS 0612	NP	-6.72	-32.87	5.29	22.38
	MSY	95.61	97.92	96.59	98.28
DTS 1218	NP	-4.09	2.39	3.36	-4.14
	MSY	36.81	27.52	51.31	94.33
DTS1824	NP	-15.86	2.58	2.48	5.01
	MSY	-0.37	-12.05	20.29	29.28
DTS2440	NP	-21.53	-2.85	-2.52	15.16
	MSY	3.09	9.33	19.76	30.10
PS0612	NP	36.34	73.87	-	25.77
	MSY	99.46	98.18	-	95.17
PS1218	NP	17.88	16.32	-	17.66
	MSY	38.98	36.32	-	45.13
PS1824	NP	41.75	7.69	-	23.01
	MSY	52.71	10.78	-	20.62
PS2440	NP	-43.90	16.81	-	-14.17
	MSY	37.65	67.05	-	54.56
Art 0006	NP	-169.81	12.18	-	11.81
	MSY	92.84	92.55	-	96.51
Art 0612	NP	2.80	-8.48	28.88	25.64
	MSY	35.60	36.88	15.03	51.89
Art 1218	NP	-3.32	-6.58	3.91	27.74
	MSY	58.81	56.15	85.36	60.48
Art 1824	NP	10.95	2.77	3.36	5.30
	MSY	88.77	90.05	90.93	93.97

- ***CR/BER***

fs_name	Variable	2013	2014	2015	2016
DTS 0612	CR/BER	0.20	-1.98	1.41	6.96
	MSY	277.69	303.41	207.62	1179.77
DTS 1218	CR/BER	0.76	1.22	1.23	0.68
	MSY	4.56	4.35	7.85	136.36
DTS1824	CR/BER	0.40	1.19	1.15	1.36
	MSY	0.98	0.25	2.52	3.82
DTS2440	CR/BER	-0.45	0.80	0.85	2.84
	MSY	1.26	1.73	2.46	5.42
PS0612	CR/BER	15.62	29.78	-	5.72
	MSY	4710.21	551.46	-	268.57
PS1218	CR/BER	3.81	3.87	-	2.86
	MSY	9.24	9.38	-	8.14
PS1824	CR/BER	11.36	1.83	-	3.00
	MSY	17.10	2.20	-	2.74
PS2440	CR/BER	-0.65	1.90	-	0.33
	MSY	4.26	10.04	-	7.45
Art 0006	CR/BER	-18.13	5.92	-	3.04
	MSY	395.13	441.31	-	422.76
Art 0612	CR/BER	1.23	0.27	4.60	4.55
	MSY	5.40	6.43	2.57	12.09
Art 1218	CR/BER	0.78	0.71	1.30	6.43
	MSY	10.80	6.91	43.76	22.64
Art 1824	CR/BER	1.95	1.23	1.23	1.68
	MSY	62.34	74.39	66.38	190.06

- ***ROFTA***

fs_name	Var_Name	2013	2014	2015	2016
DTS 0612	ROFTA	-72%	-163%	20%	60%
	MSY ROFTA	247.82	164.96	100.61	119.16
DTS 1218	ROFTA	-12%	9%	9%	-13%
	MSY ROFTA	182%	143%	276%	55.05
DTS1824	ROFTA	-37%	8%	8%	17%
	MSY ROFTA	-1%	-34%	76%	131%
DTS2440	ROFTA	-37%	-7%	-6%	42%
	MSY ROFTA	7%	25%	65%	102%
PS0612	ROFTA	632%	1291%	-	187%
	MSY ROFTA	2034.49	247.01	-	106.21
PS1218	ROFTA	135%	139%	-	113%
	MSY ROFTA	397%	406%	-	431%
PS1824	ROFTA	200%	36%	-	110%
	MSY ROFTA	311%	51%	-	96%
PS2440	ROFTA	-106%	58%	-	-44%
	MSY ROFTA	210%	580%	-	430%
Art 0006	ROFTA	-398%	157%	-	31%
	MSY ROFTA	8196%	14010%	-	6491%
Art 0612	ROFTA	12%	-37%	135%	110%
	MSY ROFTA	230%	273%	59%	343%
Art 1218	ROFTA	-8%	-20%	11%	119%
	MSY ROFTA	370%	418%	1622%	476%
Art 1824	ROFTA	39%	9%	14%	19%
	MSY ROFTA	2490%	2950%	3981%	5225%

- ***Labour Productivity***

fs_name	Varb_Name	2013	2014	2015	2016
DTS 0612	GVA/FTE	28.11	15.87	21.40	35.41
	MSY	1332.79	1592.87	876.63	2342.17
DTS 1218	GVA/FTE	21.43	20.64	30.77	26.21
	MSY	50.03	35.73	81.99	1120.05
DTS1824	GVA/FTE	19.62	26.80	28.25	32.12
	MSY	32.11	18.77	40.67	52.81
DTS2440	GVA/FTE	11.27	30.93	31.27	44.62
	MSY	34.63	40.54	49.26	60.52
PS0612	GVA/FTE	39.18	96.43	-	25.76
	MSY	4604.89	1382.24	-	390.78
PS1218	GVA/FTE	33.81	34.91	-	27.06
	MSY	49.80	49.96	-	44.42
PS1824	GVA/FTE	47.31	35.20	-	30.50
	MSY	60.96	36.85	-	29.25
PS2440	GVA/FTE	36.03	86.69	-	51.12
	MSY	203.59	278.53	-	164.82
Art 0006	GVA/FTE	13.93	40.48	-	22.31

	MSY	668.73	631.63	-	632.27
Art 0612	GVA/FTE	82.80	100.95	115.42	104.92
	MSY	150.13	202.11	88.87	183.09
Art 1218	GVA/FTE	58.42	65.57	77.52	131.66
	MSY	223.09	240.70	831.67	285.59
Art 1824	GVA/FTE	30.31	23.09	23.21	26.98
	MSY	497.48	463.38	425.03	775.98

- ***GVA/Vessel***

fs_name	Var	2013	2014	2015	2016
DTS 0612	GVA/Vessel	46.75	24.94	61.64	38.52
	MSY	2216.87	2503.09	2524.69	2548.03
DTS 1218	GVA/Vessel	68.10	85.09	84.38	68.34
	MSY	158.97	147.30	224.82	2920.89
DTS1824	GVA/Vessel	46.01	113.47	123.11	135.82
	MSY	75.30	79.48	177.23	223.27
DTS2440	GVA/Vessel	36.10	151.52	174.02	219.04
	MSY	110.95	198.62	274.10	297.07
PS0612	GVA/Vessel	128.54	137.18	-	83.01
	MSY	18143.28	2089.94	-	1564.67
PS1218	GVA/Vessel	227.24	248.93	-	203.89
	MSY	334.78	356.27	-	334.71
PS1824	GVA/Vessel	348.64	348.10	-	328.98
	MSY	449.24	364.49	-	315.47
PS2440	GVA/Vessel	178.51	551.41	-	360.18
	MSY	1008.72	1771.68	-	1161.30
Art 0006	GVA/Vessel	5.22	23.05	-	12.40
	MSY	250.69	359.71	-	351.52
Art 0612	GVA/Vessel	26.67	29.94	34.86	32.84
	MSY	48.36	59.94	26.84	57.30
Art 1218	GVA/Vessel	34.65	45.30	54.05	89.01
	MSY	132.33	166.29	579.88	193.09
Art 1824	GVA/Vessel	188.90	167.19	239.59	142.47
	MSY	3100.41	3355.53	4386.78	4097.15

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CIHEAM

El Máster Internacional en GESTIÓN PESQUERA SOSTENIBLE está organizado conjuntamente por la Universidad de Alicante (UA), el Centro Internacional de Altos Estudios Agronómicos Mediterráneos (CIHEAM) a través del Instituto Agronómico Mediterráneo de Zaragoza (IAMZ), el Ministerio de Agricultura, Pesca y Alimentación (MAPA) a través de la Secretaría General de Pesca (SGP).

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The Master is developed over two academic years. Upon completion of the first year (a programme based on lectures, practicals, supervised work, seminars and technical visits), during the second part the participants devote a period of 10 months to initiation to research or to professional activities conducting an original research work through the elaboration of the Master Thesis. The present manuscript is the result of one of these works and has been defended before an examination board.